Environmental Management

edited by
Santosh Kumar Sarkar

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Preface

Environmental management is a global issue and thus taking priority due to steady increase in industrialization, urbanization and enormous population growth. In the wake of intensification of the problem of global environment change, mankind faces severe challenges to overcome the disastrous impact on the health of the ecosystem. Hence an attempt has been made through this book to provide a gist of current, relevant and comprehensive information on various aspects of sustainable management of the environment.

The book is organized basically in 12 chapters, heterogeneous in nature, dealing with wide spectrum of delicate and emerging environmental issues of different parts of the world to broaden its international coverage. The reader encounters lots of important and interesting information embedded in the book, covering diverse ecotypes in environment, from tropical to temperate.

In chapter 1 the authors have illustrated very precisely the role and impact of the small enterprise, i.e. SMEs, in different economic sectors in EU in compliance with the environmental management system, which is dominated by the micro enterprises accounting for about 93% of the total number of SMEs, followed by small and medium-sized enterprises. They have observed that the most important barrier is the inability to monitor the environmental performance of SMEs due to the lack of data. They have also given due emphasis to how the ever-increasing number of SMEs faces the new challenge of environmental management and the nature of difficulties, drawbacks, benefits and advantages they expect from the implementation of SMEs.

Chapter 2 stresses the environmental waste management in construction industry, which has an important effect on the socioeconomic development and also sets an indelible seal on the surroundings and the environment. The author assumes that the companies must equally take care of the society and environment along with corporate profits and shareholder value. Safeguarding, creation of jobs and commitment to environment and society are as important as innovative, problem-solving expertise and open dialogue. The author has rightly asserted that top management has a key role in building awareness and motivating employees by explaining the organization's business and environmental issues.

Viticulture (wine growing) represents one of the cultivations that has most impact on ecosystem due to its distribution and geographical concentration. In Chapter 3 the authors advocate to modify the management techniques of viticulture farms by integrating economic, social and environmental spheres for a sustainable management. Land and water salinization, diminished air quality, soil erosion, outbreak of pests are some of the very important and potential threats to natural resources related to viticulture. Hence the authors rightly recommend the improvement of the eco-sustainability of organic and conventional viticulture through a conscious and appropriate agronomic management.

Strategic environmental assessment (SEA) presents one of the most important and potential instrument for implementation of the sustainable development strategy within planning process. In chapter 4 the authors present a selected case study in Serbia narrating the experiences of the implementation of SEA with special reference to the regional plan of waste management.

A good understanding of the benefits of environmental design and management as well as social effects of relevant policies is important to increase the quality of life in urban areas. In chapter 5 the author presents a case study with data from Beijing, China, and stresses that planning and design, incompatibility with surrounding neighborhoods and property management of neighborhoods are three potential factors influencing the quality of residential environments.

In chapter 6 the author has provided in-depth information on the trends and increasing power of environmental non-governmental organizations (NGOs) in sustainable development, structures, functions, planning and management processes of environmental NGOs. He also provides help to cultivate technical skills and leadership qualities for possible professional careers with environmental NGOs.

In chapter 7 the author emphasizes the most important perspective in recycling of aluminium called the 'secondary aluminium', which could be divided into two categories: pre-consumer by-products from the production of primary aluminium, and scrap, associated with post-consumer aluminium. The article summarizes the recovery and management of salt cake, an important by-product of considerable economic value, generated when salt fluxes are used to improve the aluminium recovery.

Chapter 8 presents the water quality characteristics of the coastal regions of Sundarban mangrove wetland, West Bengal, India, a UNESCO World Heritage Site. The authors have considered a substantial water quality data set to establish the present ecological status of this most vulnerable ecosystem. They have efficiently applied the multivariate statistical techniques like cluster analysis, canonical correspondence analysis and factor analysis for perfect interpretation and understanding of the water quality status. The authors recommend some important remedial measures to mitigate the ongoing problems of water quality deterioration which is directly related to the rate of productivity of this fragile ecosystem.

In chapter 9 the author attempts to illustrate the interaction between heavy metals and aerobic granules. In addition, the effects of heavy metals on the aerobic granular sludge system have been discussed and wastewater treatment performance, including the removal of chemical oxygen demand (COD), nitrogen and phosphorous in the presence of heavy metals have been summarized.

Chapter 10 reviews the unique trade-offs between environmental protection and economic development in high alpine areas. It covers a wide coverage of the high mountain systems such as its biology, environmental management, policy tools, etc.

Chapter 11 explores the most comprehensive integrated coastal area management in the perspective of spatial planning and sustainable development. The author has given due stress in applying two newly launched spatial indicators, 'anthropogenic intensity' and 'coastality', for exploring and monitoring the coastal areas in the framework of environmental management.

The last chapter presents a broad spectrum of the geology, microecological environment and conservation of Lonar lake, Maharashtra, India. The lake that evolved in the resulting basaltic rock formation is both saline and alkaline in nature and provides habitat for an array of wild lives. The author has presented an extensive account of the physicochemical parameters of the lake and established the present status of the water quality characteristics. In addition, he has also given due emphasis to the characteristic nature of the aquatic microbes and microalgae and their salient characteristics. Unfortunately, there is deterioration of the lake ecosystem due to pollution, deforestation, excavation activities, etc., and hence the information provided in this chapter would of great significance from ecological and management point of view.

To sum up, the book makes a meaningful and provocative contribution to the sustainable management of the environment in a true sense. I wish to express my sincere thanks and gratitude to all eminent scientists / scholars who have contributed to this book. I hope this publication will be a reference document to serve the needs of researchers of various disciplines, policy makers, planners and administrators to formulate strategies for environmental management.

The SCIYO staff needs a special appreciation and acknowledgement for publishing this book with self-styled elegance. I especially appreciate the support and encouragement from Ms Iva Lipovic to complete the whole process of publication in time. I would be very proud to work with SCIYO again in the near future.

September, 2010

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1

Environmental Management System and SMEs: EU Experience, Barriers and Perspectives

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1. Introduction

SMEs are defined as enterprises which employ less than 250 employees and which have an annual turnover not exceeding €50 million, and/or an overall balance sheet not exceeding €43 millions (European Commission 2003). There are some 23 million SMEs in the EU providing approximately 75 million jobs (66% of private employment and up to 80% in some industrial sectors such as textile, construction or furniture) (European Commission 2005) . Moreover, micro enterprises[1] account for almost 93% of the total number of SMEs, 6% are small enterprises[2] and less than 1% are medium-sized enterprises. Small and medium-sized enterprises represent a large part of EU economy, being some 99% of all enterprises and 57% of economy value added (European Commission 2005), as such they also have a primary role to play in shifting the EU economy to more sustainable production and consumption patterns.

SMEs are active in a range of sectors across the EU: 22.2% in the service sector (i.e. business to business services); 20.4% in personal services (i.e. business to consumer services); 20% in retail distribution; 11.9% in manufacturing; 11.6% in construction; 8.1% in wholesale trade; 5.5% in transport and communication; and 0.2% in extraction and energy. The presence of SMEs in different economic sectors varies between Member States. SMEs are far from being a homogenous group. However they have a number of features in common, and do certainly encounter similar problems in relation to environmental compliance and performance.

Since they represent such a large percentage of economic activities, SMEs have a significant impact on the environment. The environmental problem does not fully emerge if one considers individual firms, although in some cases there can be significant impacts on local environments and communities exerted by a single SME, but pertains their combined and cumulative impact.

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[1]Within the SME categories, a microenterprise is defined as an enterprise that employs fewer than 10 persons, and whose annual overall turnover and/or annual balance sheet does not exceed EUR 2 million (European Commission 2003)

[2]Within the SME categories, a small enterprise is defined as an enterprise that employs fewer than 50 persons and whose annual overall turnover and/or annual balance sheet does not exceed EUR 10 million (European Commission 2003).

Experience in applying and enforcing environmental legislation in the Member States has shown that it is too complex and burdensome for companies and public authorities to determine the detailed contribution made by SMEs to pollution (e.g. air pollution), in terms of the "environmental burden" from different types of pollutants (e.g. CO2, SOx, NOx, etc.). The first and most relevant barrier is the inability to monitor the environmental performance of SMEs, owed to the lack of data (that in many cases does not even exist). There are many studies in literature attempting to provide 'insights' into environmental problems emerging from SMEs. These studies focus on specific environmental aspects. For instance, a recent report (Marshall 1998) estimated that SMEs account for 60% of total carbon dioxide emissions from businesses in the UK and concluded that there is substantial room for improvement in energy efficiency and emissions reductions to be carried out by these companies. Another survey carried out in France showed that SMEs are to be held responsible for 40-45% of all industrial air emissions, water consumption and energy consumption, as well as for 60-70% of industrial waste production (Daddi *et al.* 2010).

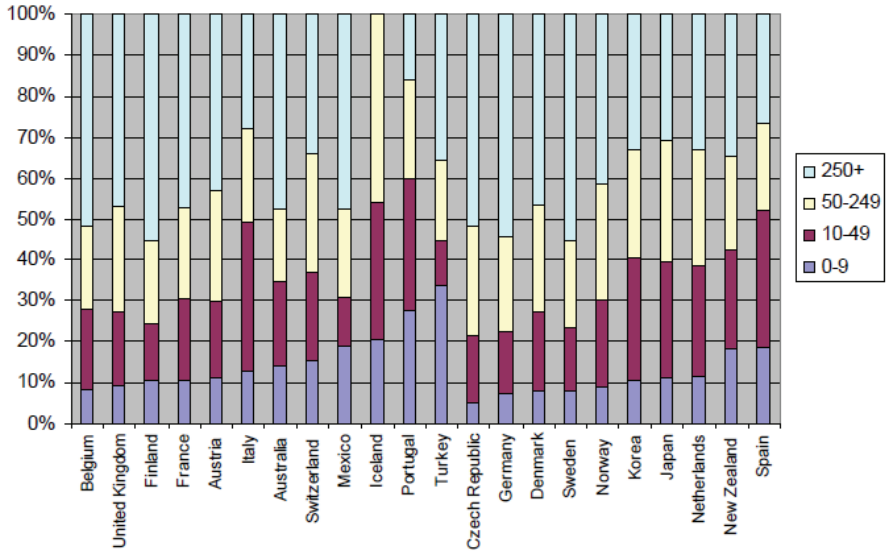

Fig. 1. Distribution of Employment by Firm Size Class, 1999 (Source: J.Labonne, 2006)

Although some smaller companies have taken the lead in managing their own environmental impacts in a well structured and effective way, the largest part of SMEs are still characterised by a lack of awareness on their environmental impacts and, especially, concerning the ways in which such issues can be effectively managed. A recent UK study (Netregs 2002) shows that only 7% of businesses in the UK believed they undertook activities that could harm the environment, but when prompted with a list of activities, this figure rose to 41%. This is a clear symptom of a low degree of knowledge by SMEs on what their environmental impacts can be. In many cases, SMEs are persuaded they do not have any impact at all on the environment. This emerges, for example, from a survey among Polish SMEs (Polish Environmental Partnership Foundation, 2007) emphasizing that 86% of the interviewees declare that their companies do not have a negative impact on the environment or that the impact was not significant at all.

Not only SMEs have a scarce knowledge on their environmental aspects, but the main problem is that most of them do not know enough about legislation applied on these aspects to ensure that they are compliant. The Institute of Directors (2006) carried out a survey reporting that members involved in sectors such as construction, mining, transport or manufacturing that are 'heavily exposed' to environmental regulation showed relatively low levels of awareness. It is quite surprising, for example, that 59% of members in manufacturing knew 'not much' or less of the environmental regulation applicable to their activities.

All the above mentioned studies show that low environmental compliance by SMEs is due to lack of knowledge and awareness of their own activities, ignorance of environmental legislation, lack of capacity to tackle their environmental impacts, and sometimes the excessive administrative and financial burden of environmental compliance. Compliance is further hindered by the perception that environmental protection is costly and has little benefit for the business.

Many studies show that the majority of SMEs have little awareness of their own environmental impacts and of how to manage them (IEFE *et al.* 2006). Moreover, literature emphasises that most SMEs are 'vulnerably compliant', since they are not always able to achieve an environmental performance that is high enough to ensure that they are complaints.

Where environmental legislation is applicable to SMEs, they tend to presume that they are complying and, as a result, full compliance is often the outcome of external action following an inspection, rather than an on-going process of checking that legal requirements are being met (Fairman & Yapp 2005). At the same time, SMEs often do not have the necessary legal and environmental expertise to cope with environmental legislation.

As European Commission has recently emphasized in the recent Program ECAP (Environmental Compliance Assistance Programme - EC COM(2007) 379), the implementation of an environmental management systems (EMS) and explicit designation of responsibility for environmental matters may have a much more positive influence on the environmental engagement of the company than a single inspection or compliance check.

The EMS is an increasingly diffused tool among organisations operating in different sectors, thanks to the drive and impulse coming from the voluntary certification schemes (such as EMAS and ISO 14001) in which they are mainly applied. These schemes provide a third-party guarantee of environmental "excellence", which is able to give an advantaged position (with respect to their competitors) to those organisations that, by adopting EMAS or ISO 14001, commit themselves to improve the environmental performance.

A wide range of evidences from existing studies analyze the benefits of EMS adoption (Patton & Baron 1995, Watson 1996, Van Der Veldt 1997, Aragaon 1998, Madsen & Ulhoi 1999).

Just to mention one of these studies, Biondi *et al.* (2000) identify in a better legal compliance and in the capability of continuously monitoring compliance one of the most relevant benefits of EMAS registration. This benefit is also connected with other forms of EMS certification. (Hamschmidt *et al.* 2001).

The EVER study, carried out on behalf of European Commission, also provided very consistent outcomes, as far as this benefit is concerned (IEFE *et al.* 2006). According to the results of this study, in fact, formal EMS (such as EMAS) provide considerable benefits in the area of legal compliance: quite interestingly, the three most important benefits perceived by the interviewed EMAS-registered organisations are connected with the monitoring and

management of legal compliance. Greater awareness of regulatory requirements was identified as a fairly or important benefit by 70% of the EMAS adopters, better compliance by 69% of them and better planning of actions for legal and regulatory compliance by 67%.
As we have emphasised, SMEs certainly have to struggle against their lack of resources and to fill a cultural gap as regards environmental matters. Several studies have highlighted the existence of several typologies of hindrances, heterogeneous in nature and forms, encountered by SMEs in the EMS implementation, such as internal or external, organisational or economic, general or category-specific (e.g.: SMEs), and so on. For instance, the cost of implementation and maintenance (in case of formal EMS implementation such as EMAS and ISO 14001), like external consulting and verification costs, seems to be a relevant barrier, especially for SMEs, where financial resources are more restricted (Biondi *et al.* 2000, Hillary 2004). Focusing on internal barriers, we can mention, for instance, the availability of management time, or the adequacy of human resources (e.g. personnel with proper skills, expertise and technical background (Biondi *et al.* 2000, Iraldo & Frey 2007). This is confirmed by the incessant call, emerging from many studies, of measures capable of simplifying and supporting the implementation and maintenance of EMSs by SMEs (e.g.:Ammenberg *et al.* 1999, Hillary 2004).
In the last years, an ever-increasing number of SMEs, are gaining interest in EMS. How are these SMEs facing the new challenge of environmental management? What difficulties and drawbacks do they have to tackle and what benefits and advantages should they expect from the implementation of an EMS?
The chapter aims at proposing some early answers to these relevant questions, that many SMEs are asking themselves before accepting the challenge. Managing the environmental aspects of their activities according to a systemic and preventive approach implies for most SMEs a considerable effort in terms of human, financial and technical resources, regardless of the specific industrial context or country in which they operate. Constraints and drawbacks as to resource availability could compromise SME participation in voluntary programmes, like the European Eco-Management and Audit Scheme (EMAS), as well as their adoption of the ISO 14001 standard. These kinds of voluntary schemes prove their efficiency and efficacy "on the field" by leading as many enterprises to a significant improvement of their environmental performance. This is the reason why, in order to correctly evaluate the implications of ISO 14001 and EMAS, we have to investigate their capability of involving SMEs.
The chapter "core" is the attempt both of evaluating these barriers on an empirical basis and of identifying favouring factors and efficient solutions to overcome them. Suggestions and indications for effective tools, feasible solutions, incentives, achievable benefits and advantages (which an improvement of ISO 14001 and EMAS diffusion among SMEs could base on) emerge from the first significant evidence ever gathered on EMS implementation by SMEs in Europe. A final focus will dedicate on networking approach called cluster approach and new opportunities for SMEs provided in the next version of EMAS Regulation (EC Regulation n. 1221/2009)

2. Barriers and constraints for SMEs

Barriers to EMS adoption are generally categorized into those that are external to the organization, and those that are internal (Milieu Ltd & Risk and Policy Analysis Ltd, 2009).

The present paragraph investigates the factors that prevent organizations from implementing an EMS.
Different "keys of interpretation" do exist for such a broad issue: indeed, barriers are heterogeneous in nature and forms: they can be broken down following different types of criteria, as hindrances can be either internal or external, organizational or economic, general or category-specific (e.g: SMEs), and so on.
This paragraph is structured in two sub-paragraphs, the first analyzing external barriers, and the second focusing on internal ones. However, in the analysis of the evidence emerging from the literature review we provide a broad, multi-dimensional picture of the issue, highlighting useful distinctions between organizational and economic, generic or SME-tailored barriers, etc.

2.1 External barriers

External barriers encompass a wide set of factors, ranging from the cost of implementation (and other economic factors) to the lack of support and guidance, from hindrances linked to the institutional framework and the verification/registration process to the lack of market recognition, and so on.
Most of the evidence gathered within the review of existing literature on these issues regards the relevance of economic factors, scarce customer awareness/interest and lack of recognition by public institutions as factors hindering the will of organizations to adopt an EMS and in particular a formal EMS such as ISO 14001 or EMAS .
The cost of implementation, for instance, seems to be a relevant barrier, especially for SMEs where financial resources are more limited (Hillary 1999, Biondi et al. 2000).
SMEs certainly have to struggle against their lack of resources and fill a cultural gap as regards environmental matters. At a first glance, the main problem for SMEs seems to be that of finding money to invest in the improvement of environmental performance. Therefore, costs connected with the implementation of an EMS and with the adoption of a voluntary scheme could represent a first kind of barrier for SMEs.
The widespread agreement over the importance of such a barrier is confirmed by many studies, like a survey on the uptake of EMAS and ISO 14001 (ISO, 2005) showing how the lack of financial resources (33%) and the costs of certification (23%) are among main barriers for the implementation of an EMS.
In detail, we can distinguish the financial costs basically in three categories: costs relating to the necessary technical measures for guaranteeing the improvement of environmental performance, costs relating to the EMS implementation and costs to be sustained for obtaining a third party certification.
As to the first cost category, we refer, only in the case of ISO 14001 and EMAS, to the costs that many participating enterprises have to face in order to comply with the environmental regulations that is a requirement of both schemes. Moreover, in the adoption of an EMS, most of SMEs' financial efforts connected with "technical measures" regard the costs of equipment and the cost relating to plants management, control and maintenance. The commitment to continuous improvement implies that plant investments should not be over with the EMAS registration or the ISO 14001 certification, but instead means that environmental improvement must, from that moment on, be considered in all the decisions regarding investment and maintenance scheduling.
Costs sustained by the SMEs in structuring their EMS represents another significant financial effort. For instance Delmas (2002) states that "the annual cost of maintaining ISO

14001 is a more important constraint than are design and registration costs"; this might be an explanation of the "crisis" of certifications in some countries characterizing recent years, as many organizations drop EMSs as costs overweight benefits. These costs are often due to the lack of expertise and trained personnel capable of performing the necessary measurement and analyses, which implies the need to rely on external technicians and consultancies. Cost of management time is another relevant cost whereas costs connected with personnel information and training as well as with environmental auditing (reported as specific items) were not considered relevant. It is important to highlight that the EMS "degree of maturity" is a relevant variable which most influences the steps which the enterprise will have to take, and consequently the additional costs. A production site where a management system has already been structured and a systematic auditing activity is regularly performed (but this rarely is the case of an SME) will obviously have considerably lower costs compared to a site which has still to take some of the organisational-managerial steps required by EMAS or ISO.

Finally, we consider the financial costs strictly connected with the adhesion to one of the formal voluntary standards such as ISO 14001 and EMAS.

The evidence gathered (Biondi *et al.* 2000, Cesqa & Sincert, 2002) suggests that external consulting and verification costs are those with a stronger impact on organizations, and are felt like a heavier burden compared to other costs such as those related, for instance, to the necessary modifications regarding production processes, or linked to product innovations (see Figure n. 2).

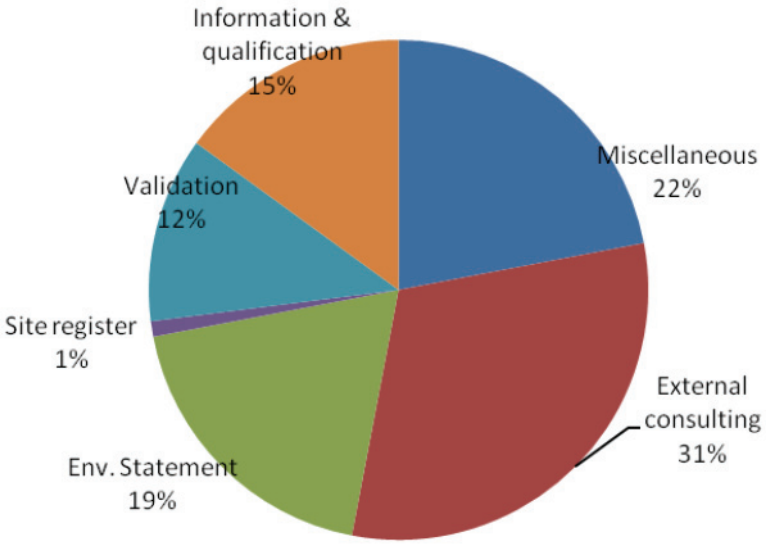

Fig. 2. Cost Categories for EMAS implementation

The costs relating to EMAS registration, for example, are generally low, although this depends on each national Competent Body. In some countries the cost depends on site dimension and turnover, representing a positive attempt to knock down a financial barrier

for SMEs. For example, in Italy the cost varies from 50 €, for small firms, to 1500€ , for large firms.

On the one hand, to give an idea of the financial resources required, we can mention the "EMAS toolkit" (European Commission, 2000), which provides figures with the average expenditures for different size-categories of organisations:

€ 10,000 for very small companies (< 10 employees)
€ 20,000 for small companies (< 50 employees)
€ 35,000 for medium companies (50 <250 employees)
€ 50,000 for large companies (> 250 employees)

On the other hand, studies on EMS costs (Hamschmidt & Dyllick 2001, Milieu Ltd & Risk and Policy Analysis Ltd, 2009) suggest that the above mentioned figures might be underestimated. The discrepancies in the outcome of different investigations are due to many factors, not least the fact that most organizations do not have a system for the accounting of environmental costs. The table below collected evidence from previous studies on the costs of EMAS implementation in different countries.

Size **Country**	**Small** **< 100 emp**	**Medium** **< 500 emp.**	**Large** **>500 emp.**	**Average**
Austria (BMUJF 1999)	109.000€	225.000€	153.000€	
Denmark (Kvistgaard, 2001)				62.000€
Germany (UBA 1999)	37.000€	84.000€	85.000€	59.000€
Switzerland (Dyllik & Hamschmidt, 2000)	56.000€	93.000€	322.000€	172.000€
Hungary (INEM 2001)	3.200€-6.2.00€	5.800€-11.000€	>11.000€	
EU member States (Ec, 2009)[3]	21.000€-38.000€	17.000€-40.000€	38.000€-66.000€	26.000€-48.000€

Table 1. Studies on the costs of EMAS implementation

Moreover, the previously mentioned Cesqa Sincert study shows how the average annual investment for the implementation of an EMS amount to about 1,9% of sales revenue for SMEs, and 5,2% for larger organisations. The problem rises from the coupling of two factors like the relevance of the costs for a business activity and the uncertainty of their precise entity. This is consistent with the evidence emerging from the EVER study, which argues that one of the main problems faced by SMEs when considering the possibility of registering in EMAS is the existence of "a priori" undefined costs, mostly related to the implementation phase (IEFE *et al*. 2006).

One of the few variables that are indirectly "linked" to the evaluation of the costs of registration, that can be gathered from literature, concerns the time-length organizations take to implement or to maintain an EMS

[3]The second amount refers the first year cost; the first amount refers the yearly cost after the first year.

In a recent study on the costs and benefits of EMAS (Milieu Ltd & Risk and Policy Analysis Ltd, 2009), registered organizations were asked to indicate the number of person-days (of either their own staff or outside contractors) required to first implement EMAS. The range of responses was quite varied. External consultancy was used by most respondents to implement EMAS (59%). There may be a trade-off between the complexity of the EMAS system (lower in smaller organizations) and the expertise available (also likely to be lower in smaller organizations). The most time-consuming tasks for internal staff are the environmental review, EMS development and internal audit. A summary of the person days required to maintain and implement EMAS by each task is provided in Figures 3 and 4.

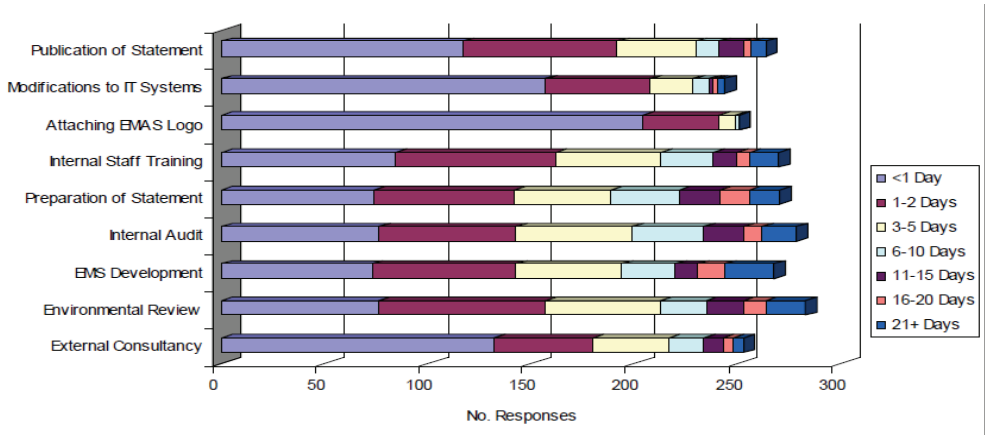

Fig. 3. Person Days to Maintain EMAS by Task (Source: Milieu Ltd & Risk and Policy Analysis Ltd, 2009)

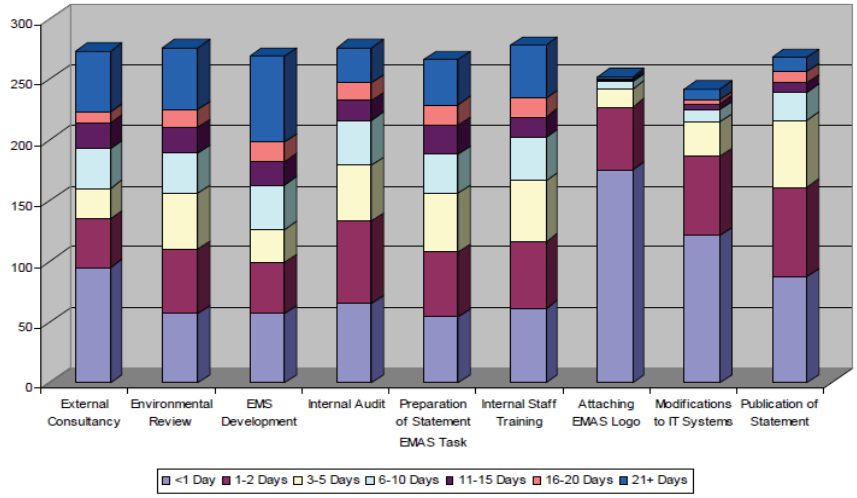

Fig. 4. Person Days to Implement EMAS by Task (Source: Milieu Ltd & Risk and Policy Analysis Ltd, 2009)

Focusing on EMAS scheme, but in some cases we can extend these considerations also to ISO 14001 certification, costs related to the implementation and maintenance of EMS, however, are not the only barriers singled out by the literature review, as most of the studies analyzed identify as main hindrances also the lack of customer interest and awareness (Kvistgaard et al. 2001, Brouhle 2000, DG Enterprise 2004), with the subsequent need to promote EMAS and its logo and the lack of recognition and positive rewards by public institutions (Carnimeo et al., 2002).

The lack of public recognition and interest affecting EMAS (and its logo) is well known, and most studies and surveys are in line with such assumption (Ends surveyed that only 6% of respondents admit EMSs being the main environmental factor orientating purchasing habits). Obviously, scarce awareness means scarce market response.

This goes for all kinds of organizations, but is probably more tackling for SMEs, which have to put a greater effort to implement the scheme, due to their limited resources. Participants of a workshop on SMEs and EMAS arranged during the EVER project argued that "*an important proportion of SMEs who have invested the effort and resources to register in EMAS do not receive any relevant benefits or appreciation… and finally drop out with a negative impression of the scheme*".

Brouhle (2000) goes a step forward analyzing the scarce level of EMAS knowledge that characterizes firms themselves, as well. He mentions a research study by UNI/ASU, establishing that over one quarter of executive managers did not know about EMAS (Freimann and Walther, 2001), and another study by the Institute for Research in Social Choices, which identified 33% who had no knowledge of EMAS and another one third who claimed to know it only partly.

As far as rewards provided by public institutions are concerned, such incentives can be either of regulatory nature or aiming to promote a wider uptake of the scheme through public procurement, funding support and technical and information support (IEFE *et al.* 2006). However, to date, the business community is particularly critical about the lack of external incentives.

The evidence emerging from the literature review clearly shows how in those national contexts (e.g: Germany in a first phase of the development of the scheme, Italy in more recent times) where the public sector is more keen on supporting the diffusion of EMAS through promotional campaign or incentives for registered organizations, the uptake of the scheme is much higher compared to other countries where such positive institutional framework does not exist. We can mention, for instance, a study carried out by De Leo (De Leo et al, 2003) on Italian and German sites. De Leo states that among chief reasons of the success of the German policy we have: i) an effective program of information and technical assistance to companies; ii) information to the public; iii) financial aid, iv) administrative simplification and deregulation.

In the abovementioned EVER study, the point of view of the organizations that are not participating in the EMAS scheme was analyzed in order to investigate the barriers preventing organizations from adopting EMAS. From the carried out interviews, it clearly appears how the role of public institutions is crucial: the lack of external incentives and the lack of recognition by the public institutions are perceived as the most relevant hindrances. Moreover, a scarce interest by consumers and the subsequent lack of competitive rewards is indicated as a strong barrier, as well, being this consistent with the findings of the literature review. The interview phase, however, provided some surprises, such as the scarce

importance given to the cost of implementation. Despite high costs associated with activities such as external consulting, most organizations suggested these being not the reason why non-participants decide not to implement EMAS.

2.2 Internal barriers

Analyzing the results mentioned in the previous paragraph, we can realise that the most significant barrier for SMEs is not the direct financial effort, but the indirect costs implied by, on the one hand, the deal of time that the management has to devote to the EMS implementation and, on the other, by the lack of human and technical resources that SMEs suffer when tackling environmental management problems. Time and knowledge therefore emerge as the most significant constraints. The smaller is the enterprise, the stronger time constraints seem to be. This is evident especially in those small firms where the management team has multiple roles and commercial pressures must take priority. The smaller is the enterprise, the higher is the probability an EMS cannot be implemented by relying only on internal expertise and technical capabilities.

Internal barriers can be defined as obstacles that arise within the firms and prevent or impede EMSs implementation or the adoption of EMSs (Hillary, 2004). They are a vast category, comprehending factors such as lack of resources (time and human capital), difficulties in the understanding and perception of the EMS scheme, drawbacks in its implementation process, the culture itself of organizations, and so on.

For instance, a first relevant hindrance met on the way for EMAS registration, according to the relevant literature (Biondi et al. 2000), is represented by the difficulties in effectively understanding the scheme and its requirements and identifying relevant environmental aspects. Indeed, it appears that many organizations are unable to accurately understand EMAS, especially as far as the Initial Environmental Review and the EMS are concerned, and to identify relevant aspects. The difficulties met in correctly identifying relevant aspects is highlighted by many studies (Hillary et al 1999, Hillary 2004). Zackrisson *et al.* (2000) shows that 49% of companies find it challenging to identify relevant environmental aspects, and more than 1 out of 4 fail to identify some significant environmental aspects. Moreover, it has been assessed by some studies that many companies evaluate the relevance of environmental aspects by the so-called "rule of thumb", and not by an objective and reproducible method (IEFE *at al.* 2006). The drafting and the diffusion of the EMAS statement represent other difficult requirements in the EMAS implementation process for many companies to understand and correctly implement. This is often due, especially as concerns SMEs, to a lack of competences and knowledge within the organization (Biondi et al., 2000).

However, other studies assert how this is not merely a matter of lack of competences. The problem can assume a different connotation: MacLean (2004) defines it a matter of "harmony" within an organization (e.g: interaction between business executives and EHS managers) on business priorities. No surprise if, given such situation, it is very difficult to set performance objectives and to hence recognize relevant aspects within EMAS to be dealt with.

The evidence collected also shows that another relevant internal barrier is represented by the lack of resources. It is clear that, besides financial resources, there are other resources that organizations need for the achievement and implementation of an EMS.

Among them, we can mention, for instance, the availability of management time, or the adequacy of human resources, being these personnel with proper skills, expertise and technical background (Kvistgaard *et al.*, 2001, Bonora & Sondermejier, 2001).

This is, once again, felt as a relevant problem for SMEs. This is confirmed by the incessant call, emerging from many studies, for measures capable of simplifying and supporting the implementation and maintenance of EMSs by SMEs (e.g.: Ammenberg et al. 1999, Hillary 1999, Hillary 2004).
We can report, as one of the most recent example, the findings of the study carried out by the Strategic SME group (ISO, 2005) in which lack of time was identified as one of the top three most important barriers when implementing an EMS) by 36% of SME respondents. Secondly, the respondents identified lack of staff resources (31%) and thirdly lack of know-how in the enterprise (21%).
The lack of resources can be even worsened by the high demands of documentation. The risk is that of focusing all (limited) resources on documentation, instead of following and developing the environmental objectives and the environmental performance. Moreover, employees in charge of the EMS might feel demotivated believing the documentation requires too much of their time, and "instead of documenting the problems, they pretend not to see them" (Malmborg 2006).
A final internal barrier is "indirect" and can be identified in the fact that the implementation of an EMS might have backlashes, for instance, by disclosing certain "environmental non compliances" that ld have otherwise remained uncovered, with the subsequent legal proceedings and additional costs. Therefore, the fear of hwouaving to sustain higher costs, instead of saving money as a consequence of the implementation of the EMS, may prevent many firms from adopting EMAS, ISO 14001 or other similar systems. With this respect, the only empirical evidence is related to a non-EU context: a survey in the US on the uptake of ISO 14001, shows how 40% of firms consider potential legal penalties from voluntary disclosure as a constraint to the adoption of the EMS while other studies show even higher figures for such barrier (Delmas, 2002).
Focusing of EMAS, the recent study coordinated by Bocconi University (IEFE et *al.* 2006) supports the idea that barriers preventing organizations from joining EMAS are mainly external. The table below shows as none of the internal ones achieves a score higher than 3 both for EMAS adopters and no- adopters (The likert scale is from 1 – not at all important, to 5 very important). Only stakeholders signaled some internal barriers as moderately important.

3. Difficulties encountered by SMEs in implementing an EMS

If an SME decides to undertake actions and activities to implement an EMS, some constraints will undoubtedly hinder this process at the operational, technical and organisational levels.
The lack of eco-management-targeted skills is the first constraint in terms of human resources which SMEs have to face when they decide to implement an EMS according to EMAS or ISO 14001.
Understanding, interpretation and application of these standards is not always simple and easy, and sometimes requires a technical knowledge of environmental issues. For instance, the troubles many SMEs experience in fully understanding and satisfying some EMAS requirements (e.g.: evaluation of the effects, definition of criteria for selecting significant aspects, measurement of continuous improvement) are partially due to their lack of technical expertise in environmental management (Biondi et. al. 2000).
Both EMAS and ISO 14001 were conceived to give indications for a correct implementation of an EMS to a wide range of enterprises, including very articulated and large

sites/organisations. This is the reason why their requirements tend to be as exhaustive and complete as possible, sometimes resulting too detailed, complex and over-dimensioned with respect to a SME. On the other hand, owing to the different kinds of enterprises they address to, neither EMAS nor ISO 14001 could have been tailored to the needs and specificities of each single site/organisation, leaving room for a flexible and agile implementation. This implies a lack of explanations, clarifications and details about what is exactly required to an EMS to work effectively and efficiently in specific conditions.

	Non participants	**Stakeholders**	**Participants**
Difficulties originating from the set up and functioning of the EMAS scheme	2,5	3,1	2,7
Difficulties in implementing the requirements	2,3	3,2	2,6
Difficulties related to disclosure through the Environmental Statement	2,2	3	2,3
Difficulties in involving, motivating or obtaining the commitment of personnel	2,2	2,6	2,8
Lack of human resources and competence	2	3,5	2,9

Table 2. The most relevant internal barriers (source: IEFE Bocconi et al. 2006)

If we consider these difficulties in understanding the standards together with the scarce human and technical resources of an SME, we can realise the kind of operational and practical difficulties these enterprises meet in applying EMAS or ISO 14001 to their site/organisation.

Usually, the most relevant difficulties met by SMEs in implementing an EMS are the initial environmental review and the definition of objectives and programmes. If we consider the whole process leading to participation in EMAS, these two difficulties are overcome only by the environmental statement (this is probably due to the scarce SME confidence with external communication tools).

Difficulties met during the initial review prove that SMEs usually have to make a great effort from the very beginning of the process leading to the implementation of an EMS. Most SMEs, in fact, have never carried out an accurate and complete analysis of the environmental effects connected with their activities. They have to focus on technical aspects before implementing an environment-targeted management framework.

Project experiences show that in many cases personnel operating in the SMEs involved is composed of specialised technicians who possess a very good knowledge of the production process (Biondi et al. 2000). These technicians are also aware of the main environmental problems connected with the process and are capable of managing them from the technical point of view. Relevant difficulties were instead encountered by SMEs as to *knowledge regarding environmental effects* and *availability of technical instruments* to perform all the necessary analyses. Even though several SMEs were acquainted with instruments and methodologies for environmental impact measurement and assessment, often *they did not have time and technical resources* to carry out an in-depth analysis on their own (Hillary, 2004).

In order to obtain a complete environmental review, most SMEs relied on consultants that in the past used to support them in dealing with compliance with environmental legislation.

As we above mentioned, difficulties are encountered by SMEs also in defining their environmental policy and programmes. This was due both to the lag in environmental

culture previously described, and to the fact that SMEs are not generally acquainted with explicitly programming and planning in detail their activities, especially with respect to issues outside their "core-business" (like environmental ones). Fixing specific environmental objectives and defining programmes for achieving them is an entirely new way of operating in this field for many SMEs, and this causes practical difficulties: what is an environmental policy? What must it include? How should programmes be decided, formulated and drafted? What must they focus on?

There is no doubt that, from the organisational point of view, most SMEs are lagging behind with respect to the eco-management frontier. Small enterprises often have neither a quality system nor a defined and formalised management system, so they have to start from scratch in structuring their EMS. The little confidence they have with formalisation in general and, in particular, with management tools like procedures, operational instructions, working protocols, registers, reporting instruments and, finally, with an "advanced" tool like auditing, often prevents SMEs from implementing an efficient, useful and "handy" EMS. The existing references for structuring an EMS (such as EMAS and ISO 14001) may result too detailed and complex for an SME. As we have seen, they may also result over-dimensioned or too vague with respect to an SME practical needs. These enterprises need clearer indications for defining a simple and agile organisational structure that enables them to easily manage the environmental aspects of their activities. According to the new indication included in the new revision of EMAS Regulation (EC, 2009), the only way for SMEs to effectively undertake the implementation process is understanding that they can satisfy ISO 14001 and/or EMAS with a "slim" EMS, tailored to their features. An "overwhelming" documentation of the EMS, for instance, can be a burden (and not a support) for SMEs, and therefore can be the hardest difficulty at the implementation stage.

Finally, the environmental audit usually implies a great effort for a small enterprise that may not possess the technical expertise and capability to perform such an activity. According to evidence emerged in the literature, the environmental audit is the tool which the SMEs involved were less acquainted with. Even if SMEs certified according to ISO 9001 standards are quite familiar with the audit tool, they previously applied it strictly to quality management and encountered relevant difficulties in applying it to environmental performance. Introducing the environmental auditing in these SMEs means a radical change in the management of their environmental aspects. They had to shift from a "spot" and compliance-targeted check to a systematic, continuous and improvement-targeted control, conceived to be a "management tool" that enables the SME both to verify the EMS effectiveness and to identify improvement opportunities.

A last drawback is the uncertainty surrounding the effects of external communication and, for EMAS, the Environmental Statement diffusion to the public. SMEs are not used to conduct activities for continuously interacting with the stakeholders and often consider the environmental aspects as a delicate and "confidential" matter. They generally have normal or good relations with public authorities, but SMEs are afraid the local community can negatively react to information regarding potential or real damages to the environment. This is the reason why SMEs are rather sceptical (when not scared) about diffusing such an information with the Environmental Statement. Strictly connected with the above-mentioned drawback is the difficulty SMEs find in writing the Statement, selecting its contents and choosing a format that can satisfy the stakeholders' expectations, without generating worries and preoccupation.

4. EMS implementation by SMEs: motivations and driving factors

In spite of the abovementioned difficulties, a significant number of SMEs has been able to register their sites under EMAS and/or to obtain certification according to ISO 14001. In fact, many SMEs are positively responding to environmental management voluntary schemes as long as they develop.

What reasons are motivating these enterprises to implement an EMS and to seek a third-party recognition of their efforts? In this paragraph we will try and identify the main motivations that may prompt a small enterprise to take this steps towards a sound environmental management, despite the relevant constraints and barriers. In the next paragraph we will analyse the benefits that SMEs can achieve by implementing an EMS, basing on the main finding emerging in the literature.

Scholars have identified several factors that could induce an organization to adopt an EMS (either certified or not), and other "pro-active" environmental strategies. In efforts to increase resource productivity while abating costs, an EMS could be adopted to bring about rationalization in the use of inputs (resources) such as energy and raw materials, and at the same time, to reduce outputs such as waste (Khanna & Anton, 2002). Moreover, the adoption of an EMS can improve the reputation and image of a company and, consequently, its relations with customers, investors, local communities and other stakeholders (Biondi et al., 2000; Bansal & Roth, 2000; Khanna & Anton, 2002; Bansal & Hunter, 2003).

Research findings also demonstrated that the regulatory obligations and other external pressures may stimulate pro-active behaviour at a managerial level and induce the implementation of an EMS (Darnall *et al.* 2008; Gavronski, *et al.,* 2008). In a recent study, Darnall *et al.* (2008), relying on aspects of institutional theory and on a resource-based view of the firm, determined that institutional pressures (i.e. regulatory, market and social pressure), resources and capabilities (i.e. employee commitment and environmental R&D) both encourage a more comprehensive EMS adoption. Moreover, overcoming information asymmetries (King *et al.,* 2005) and complying with increasing legal requirements (Biondi *et al.*, 2000), represent other specific determinants

A first indication drawn from the literature review regards the extreme heterogeneity of factors "driving" companies towards EMSs (and, specifically, towards EMAS). These vary significantly in connection with different aspects, like the size of the organization (SMEs vs large companies), its sector (e.g: manufacture vs Public Administration), the national or regional contexts, and so on.

For instance, drivers can be either economic/strategic or "environment-led"; they can deal with the internal sphere of an organization (e.g: optimization of organizational activities), or be "external" such as the desire to gain a competitive advantage or benefit from fiscal/normative incentives and facilitations.

The following table summarizes some of the motivations behind the adoption of EMS that have been identified in literature.

The evidence gathered by researchers shows that economic and strategic drivers seem to prevail in spurring companies towards the EMS adoption in particular formal EMS such as EMAS. We can mention, for example, the outcome of a German UBA research (Clausen *et al*, 2002): economic and competitive motivations (such as energy/resources savings, better image, etc.) are very important.

As far as EMSs are concerned, the Best Project (DG Enterprise, 2004) stresses that the reasons for adopting an EMS (including EMAS) mostly encompass other strategic factors, not directly linked to competitiveness or the market response, such as the hope to get benefits

from local authorities: public recognition, material advantages (cheaper insurance, easier access to finance, privileges in public procurement), regulatory relief/deregulation and so on (even when these benefits are not available yet).

Reduction of environmental impacts
Savings from energy and resources consumption
Image improvement
Legal compliance
Satisfy requests by customers
Obtain competitive advantages
Regulatory and monetary incentives (de-regulation, tax relief)
Better organization and management of activities
Keeping up with competitors
Improve relationship with stakeholders and local communities
Better risk management
Satisfaction of requests from corporate headquarters
Improve rating in access to public funding and procurement procedures

Table 3. Motivation of EMS adoption

In addition, Perkins and Neumayer (2004) agree that the cost-reductions, benefits and profitability of EMAS are major drivers, but he adds that they are unlikely to be the only ones, as firms often adopt organizational innovations for managers' quest for external legitimacy, and specifically, the need to conform to widely held beliefs of rational and efficient management practice. Hence, the participation in EMAS is likely to be shaped by two sets of factors: those influencing the financial costs, benefits and profitability of the scheme, and "ideational forces" such as the requirements of external stakeholders.
Moreover, Anton *et al.* (2004) found that also the prevention of "negative" strategic factors is often a powerful driver for EMS adoption (in particular EMAS and ISO 14001), such as liability threats and pressures from consumers, investors and the public.
Even if the prevalence of economic and strategic factors is a general trend characterizing most studies, there are cases where also environmental aspects seem to play a crucial role. As an example, we can cite a survey carried out on French EMAS registered organizations (Schucht, 2000): the results, reported below, evidence how the improvement of environmental performance is regarded as the main motivation for EMAS adoption, more important than improvement of image, legal compliance and so on.
As reported by the relevant literature on environmental reporting and EMAS statements (e.g.: Grafé 1996, Gorla & Iraldo 1998, Jones et al. 1999, etc.), the willingness to communicate with the stakeholders can be a powerful driver for EMAS participation. Some of the analyzed studies put an emphasis on the fact that, in some cases, EMAS has been preferred over ISO 14001 thanks to the possibility to use and diffuse credibly validated environmental information (Gorla & Iraldo 1998).

The analysis of existing evidence was not limited to the (however prominent) EU context, being for instance inclusive of the uptake of the ISO standard and its drivers in different contexts such as the US and China (Fryxell and Szeto 2002, Delmas 2002 etc.), for comparative purposes.
As in the case of EMAS for the EU context, it emerges that economic and strategic drivers play a key-role, even if their relative importance varies according to the study, the geographical context, etc.
For instance, the main drivers for Iso-certification in China (Fryxell and Szeto 2002) were reported to be to ensure regulatory compliance, to enhance the firm's reputation, and to improve environmental performance, in that order, while motivation to achieve cost reductions is less emphasized.
A key finding emerging from the literature review is that of the prevalence of "external" drivers over "internal" ones.
For instance, we can report the Cesqa Sincert research, carried out in 2002 in Italy: main motivations for the uptake of ISO are image improvement and legal compliance (53% and 55% of respondents, respectively, rate such drivers as "very important"), while a better organization and rationalization of activities is regarded as less important (Cesqa & Sincert, 2002).
Again, Hamschmidt & Dyllick (2001) asserts that the principal driver for the uptake of an EMS (including EMAS) is external (enhancement of the corporate image), while internal factors such as the systemization of existing activities and risk minimization follow in lower positions.
Focusing on SMEs, there is a lot of evidence on the analysis of drivers of EMS adoption (Biondi et al. 2000, Goodchild 1998, ISO 2005, etc), most of which is gathered in a 1999 and 2004 studies by Ruth Hillary.
It emerges that one of the driving forces spurring SMEs towards EMAS and other EMSs is the specific request of important and large customers, as small firms are more dependent on precise demands by clients representing an important share of their activities (Testa & Irado, 2010). Moreover, other important drivers emerging in most of the studies and research being analyzed regard legal compliance, improvement of public image and the possibility of benefiting from special funding or incentives from the legislation and the Public Administration. Overall, external and economic/strategic factors maintain their prevalence even in the "sub group" of SMEs.
Most SMEs are aware that maintaining a continuous compliance to environmental legislation is problematic and implies a great managerial effort. This is particularly true in countries where environmental aspects are dealt with in a relevant number of legal provisions, applied at different levels (national, regional, local...). Moreover, environmental laws are subjected to frequent and sudden updating and tightening, which are difficult to keep up with for SMEs. In fact, these enterprises are often cut off from flows of information regarding these issues. Finally, SMEs face problems in "translating" environmental legislation requirements at the operational level, as well as in understanding their implications for the site/organisation activities. Many SMEs involved in the pilot projects believe that an EMS can be, first of all, *a useful instrument to manage, control and monitor the legal compliance*.
According to Biondi et al. (2000) other drivers should probably be attributed to the willingness to anticipate or to respond to the request of important customers. International behemoths are increasingly asking suppliers to guarantee for the environmental efficiency of their activities by adopting an environmental management standards. The relationship

between "proactive" large companies and supplier SMEs represents one of the most powerful springs for favouring the diffusion of EMS. This is already happening in many industrial sectors and in many countries. In Italy, for example, one of the first SMEs to move towards EMAS in the food-processing sector was prompted to do so by its main customer (the Swiss retailer MIGROS).

Potential improvements of the relations with the stakeholders are not a relevant motivation (Biondi et al. 2000). This is probably due to the fact that SMEs are not eager to adopt a communication strategy towards external stakeholders and, consequently, they do not consider this as an environmental improvement opportunity. Small enterprises are not used to diffuse to the public information regarding potential or real environmental impacts. Symmetrically, local communities still lack in stimulating SMEs to communicate on these issues. The bottom line is that few SMEs decide to adopt an active communication strategy, for example by diffusing the environmental statement foreseen by EMAS, because they are afraid to provoke alarmism.

A last motivation should be mentioned, although definitely less emphasized than the others. Environmental management standards is increasingly being adopted by SMEs the more they understand that these schemes require an organizational, technical and financial effort which is proportioned to the needs and possibilities of the enterprise. For example, small enterprises do not need to highly formalise the EMS procedures and prepare a wide and detailed documentation, and they can decide the "speed" and the stages of the continuous improvement according to its innovation capability.

The driving factors described in this paragraph can convince an SME to undertake the implementation of an EMS. There are some benefits which are not evident when this decision is taken, but may emerge "ex-post", once the first actions to improve environmental management are carried out. We should emphasise these benefits to make SMEs realise and correctly evaluate all the opportunities connected with a sound environmental management. Once SMEs will be aware of benefits, these could become a powerful incentive to adopt an environmental management standard.

5. EMS positive implications and benefits for the SMEs

Empirical evidence emphasizes that relevant benefits and possible advantages for smaller enterprises can be achieved by implementing an EMS. Diffusing the experience on benefits and advantages that result from the adoption of an environmental management standard is the only way to promote SMEs participation.

The experience of many SMEs shows that by implementing an EMS they are able to raise the organizational and management efficiency of the whole company (Biondi et al. 2000). For instance, they improve the capacity of managing and controlling their environmental performance, by continuously monitoring their activities (by means of procedures and operational control), systematically registering and evaluating environmental effects and periodically verifying the effectiveness of the whole system (auditing). A second relevant benefit emerges from a better definition of responsibilities and tasks, achieved through the definition of formal documents (charts, job descriptions): this enables employees to identify persons responsible to which refer to for environmental aspects and problems. This can led SMEs to a more efficient, rapid and effective management of environmental risks. Documentation represents a significant benefit also because SMEs, by writing procedures, rationalising and standardising their activities, improve their work efficiency and quality.

Training and information of personnel implies benefits in terms of efficiency, too. By improving the skills and raising the awareness of the personnel, SMEs can obtain positive management results. A clear and diffused example of this kind of benefits is what happens to SMEs implementing a waste management programme. Even if these SMEs have been pursuing waste separate collection before implementing an EMS, they obtain positive results (and connected economic benefits) only when they adopt procedures and adequately train personnel to behave correctly.

As to management efficiency, a further benefit deriving from the improvement in planning activities (Iraldo et al. 2009).

Moreover, as we have seen, one of the most effective drives towards EMS implementation is the possibility of using this management tool as a support for pursuing legal compliance. These considerations rely on a wide range of evidences from existing studies that analyze this kind of benefit of EMS adoption. Just to mention one of these studies, Biondi *et al.* (2000) identify in a better legal compliance and in the capability of continuously monitoring compliance one of the most relevant benefits of EMAS registration. This benefit is also connected with other forms of EMS certification. Hamschmidt et al. (2001), for instance, state that legal compliance is perceived as a relevant benefit deriving from ISO 14001 certification (59% of the sample), ranking at the second place right after the systematisation of existing environmental activities.

The EVER study, carried on behalf of European Commission, also provided very consistent outcomes, as far as this benefit is concerned (Iefe Bocconi *et al.* 2005). According to the results of this study, in fact, formal EMS (such as EMAS) provide considerable benefits in the area of legal compliance: quite interestingly, the three most important benefits perceived by the interviewed EMAS-registered organisations are connected with the monitoring and management of legal compliance. Greater awareness of regulatory requirements was identified as a fairly or important benefit by 70% of the EMAS adopters, better compliance by 69% of them and better planning of actions for legal and regulatory compliance by 67%.

Although this internal benefits can represent a relevant stimulus for encouraging SMEs to adopt an EMAS, we think that a real diffusion of this tools will be possible if adopters can achieve also competitive benefits.

The general impression deriving from the analysis of the evidence emerging from previous studies is that EMS adoption, and in particular certified EMS, is actually able to exert a positive influence on competitiveness, even if the effective relevance in supporting it is not certain.

The variety of perspectives and levels of analysis at which the concept of competitiveness may be considered complicates the formulation of an univocal definition of competitiveness, both at a theoretical and political level.

At the firm level, competitiveness implies that companies are able to produce goods and services more efficiently and/or effectively than their competitors. A strong competitive performance is achieved by relying on some "competitive factors", often with a particular focus on process productivity and the efficient use and/or access to strategic inputs. Jenkins (1998) states that, "*a firm is competitive if it can produce products or services of a superior quality or at lower costs than its domestic and international competitors. It is therefore synonymous of a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners*". A recent paper for the International Energy Agency defines competitiveness at the firm level as "*The ability to maintain and/or to expand [a] market position based on its cost structure*" (Reinaud, 2005).

Regarding the analysis of the key variables affecting competitiveness as well as the ways to measure them, we may distinguish two major approaches:

- The first one tries to investigate the *drivers of the competitiveness* (e.g. the resource productivity at firm level, the degree of internationalization at sector level).
- The second approach focuses on the *external effects of the competitive success* (e.g. the market performance measured by market share; the turnover growth rate; the financial performance measured by ROI or EBTIDA).

At the *level of firms/plants*, competitiveness indicators relate to various aspects, such as the ability to sustain market shares, to sustain independent existence on the market or to sustain "normal" levels of profitability and returns. At the firm level, *productivity* is the key variable, simply defined as the "*measure of output per unit of input*". Productivity aims at measuring the efficiency with which production is carried out; in other words, the ratio between the outputs and inputs that make production possible (raw materials, labour, capital etc). Many studies identify as an optimal measure of productivity the *Total Factor Productivity*, that is a synthetic measure of how firms are organised, structured, use technology and are managed (for example: Jaffe and Palmer, 1997; Dofour *et al.* , 1998; Berman and Bui, 2001).

In the following section, we analyze the main evidence emerging from literature on the effect of EMS adoption on the different measure of competitiveness.

The introduction of an EMS should enable an organization to identify opportunities for the better management of resources, including saving in raw materials and energy in the supply chain of an organization, or in the reuse or recycling of resources. Such steps reduce consumption and in turn reduce the operating costs of that organization (Milieu Ltd & Risk and Policy Analysis Ltd, 2009)

Most of the literature agrees on the benefits provided by EMS adoption, in particular by EMAS registration, in terms of cost savings. In a relatively recent review of existing studies on the issue (Clausen et al. 2002), most of the works taken into consideration show that EMAS implementation supports firms competitiveness, thanks especially to the lower costs they can obtain.

Cost savings are relevant not only in general terms, but also in comparison with other benefits deriving from the EMAS registration. We can mention, for instance, a study (Imperial College *et al.* 1998) showing how cost reduction is actually the main benefit associated with the implementation of the scheme.

Also the studies that more generically deal with EMSs (and not EMAS-specific) show how cost savings represent one of the main dimensions on which the certification supports competitiveness (Petrick et al. 1999). Indeed, it appears that all kinds of EMSs do actually spur competitiveness of firms as they operate as cost-cutting measures, especially as far as some issues like greater energy efficiency and reduced resource consumption are concerned. We can mention, as an example, a study carried out in 2001 (Hamschmidt et al, 2001), showing how 50% of Swiss ISO-certified companies perceive cost reduction as a relevant benefit deriving from the implementation of an EMS.

Regarding the promotion of innovation at firm level, EU environmental policy has the broad aim of influencing the innovation process and technological development within firms in favor of cleaner techniques and technologies responses (Hilliard et al. 2003). The underpinning idea is that the adoption of environmentally friendly techniques and technologies, concerning the take-up of methods improving the productivity of resources, will overcome the traditional trade-off between increased competitiveness and enhanced environmental protection.

The findings emerging from literature that show a positive relation between EMS, or certified EMS and innovation, are mainly anecdotal but just few empirical researches found generalizable results (Clausen *et al.* 2002).
For instance, with reference to the direct effects of EMAS adoption on competitiveness, a recent European study (Rennings et al. 2006) investigated the impact of the different characteristics of this EU Scheme on technical environmental innovations and economic performances in Germany, by analysing data from a unique dataset of EMAS-registered sites. The study identifies a weak relationship between EMAS and some indicators of market success. However, a positive impact on the increase of turnover and exports is found, especially when a company is able to achieve significant learning by adopting EMAS. Hence, the authors conclude that a better linkage between environmental management and innovation management could improve competitiveness.
Furthermore, a recent study by Iraldo et al. (2009), based on a sample of 100 interviewed organizations investigated whether or not an EMS implemented within the EMAS Regulation has an effect on firm performance both from an environmental and a competitive point of view. The econometric analysis shows a positive impact of well-designed environmental management system on environmental performance and, as a consequence, on technical and organizational innovations.
The fact is that a simple EMS adoption, even if complying with a third part designed standard, such as ISO 14001 or EMAS, does not per se assure an improvement of competitive performance. The relation is neither direct nor "automatic", but it depends on the effects of the EMS on the organisation environmental performance. In other words, if only an EMS achieves the aim for which it was designed, or the continuous improvement of environmental performances, a positive effect on firm competitiveness could be attained.
Another dimension of competiveness potentially affected by EMS adoption refers its "direct" indicators such as market shares, increased sales and revenues and improved market position.
The findings emerging from the literature are consistent with the idea that only part of the above-mentioned benefits support a concrete improvement of the competitiveness of EMAS organizations. It seems like the main benefits are either immaterial (such as a better image) or linked to the internal sphere of the company (e.g: lower costs or better management and rationalization of activities), and not directly linked to the market response.
Indeed, even if there is evidence that the implementation of an EMS does actually result in an increase of competitiveness (Feldman 1997, Bonifant et al 1995, Hart et Ahuja 1996), many other studies focus on the lack of market pull as a relevant hindrance on the way of an effective exploitation of EMAS competitive capabilities (Kvistgaard et al. 2001).
To mention some example of a positive relation between EMAS and market response, Hamschmidt *et al.* (2001) shows how 28% of Swiss companies only experienced an improvement in their market position as a consequence of EMS adoption, while some of the previously investigated benefits, such as legal compliance or activities' rationalization, are far more important.

6. Co-operation: a key word

Networking and cooperation between organisations emerges from several studies and empirical evidences as one of the most important factors fostering the diffusion of formal EMS (such as EMAS). Many authors (*inter alia*.:Biondi *et al.* 2000, Hillary 2004) emphasise

that working with groups of companies is a useful and efficient way of adopting EMAS particularly for SMEs. Moreover, the European Commission has recently confirmed the key role of networking for overcoming the constraints and barriers for EMS adoption between SMEs (European Commission 2007). The Commission has, in fact, highlighted its commitment to promote and encourage the use of EMAS in industrial clusters or districts of SMEs, using specific cluster- or supply chain-oriented approaches, because these approach can reduce consultancy and audit/verification costs for SMEs, and facilitate additional knowledge-sharing and experience exchange amongst participants.

The effectiveness of the networking approach particularly emerges between organisations operating in the same sector (such as the industrial sector, but even service sectors like tourism or public institutions operating at different levels) and between organisations operating in the same region (or territorial area).

In the first case, enterprises can co-operate by identifying and assessing similar environmental aspects and by finding technological and operational solutions that can be applied to similar production processes and products, as well as by defining organisational structures suitable for the same kind of production cycles. In the second case, co-operation is facilitated by the 'physical contiguousness' and there are synergies both in improving the environmental impact on the same local eco-system, and in interacting and communicating with the same stakeholders (local population, authorities, etc..).

In some experiences, a network has been created among SMEs within a 'cluster', in order to foster information exchange and experience diffusion and to define and apply common solutions to similar environmental, technical and/or organisational problems, or to share environmental management resources (Iraldo & Frey, 2007). A specific kind of co-operation within a cluster of organisations takes place in the supply-chain: when a large customer, for example, is willing to support small suppliers in the EMS implementation process, then all the smaller organisations involved in the supply chain can benefit greatly from networking. This approach proved to be effective in some Member States as Germany ("Konvoi" approach), Spain (co-operation in the tourism supply chain), Nordic Countries (Denmark and Sweden) but in particular in Italy by means of the so-called APO "Ambiti Produttivi Omogenei", it has shown a real effectiveness in promoting the environmental compliance of SMEs.

The Italian experience is particularly relevant also from the methodological point a view. An operational path was, in fact, outlined and experimented by several industrial clusters. It consists in several steps that lead the firms belonging to the same cluster and their local stakeholder in the implementation of an environmental management system at the cluster level, mirroring the main requirements set by the Regulation EC/761/2001 for individual organisations.

The **initial step** is the set up of an EMS Promotion Committee at cluster level. This Committee is composed both of public (e.g.: Province or Municipalities) and private (e.g.: trade associations, NGO, enterprises, firms managing public infrastructure as sewerage and purification system) actors and is in charge of defining the strategic guidelines for the cluster environmental policies and of implementing some "common resources", in order to guarantee a coordinated and integrated management of environmental issues within the Cluster.

The **second step** is the Initial Environmental Review referred to the Cluster. This review enables to identify the most relevant and critical environmental aspects for the cluster and the its specific production. The aim of the Environmental Review of the Cluster is to support

the involved organisations to identify and assess their own environmental aspects, according to EMAS Regulation and ISO 14001 standard.
As **a third step**, the Promotion Committee defines and shares a Cluster environmental Policy, becoming a reference for the EMS policies of all the SMEs involved in the cluster. The Environmental Policy of the cluster sets the guiding principles and general priorities based on the most significant environmental aspects and impacts, resulting from the previous review. From the Cluster Policy a collective and co-operative Environmental Programme and relating improvement objectives and targets are defined in each cluster, pursuing the principle of continuous improvement.
Once the Cluster Programme and the shared environmental objectives and targets have been adopted and recognised, by means of a sort of "Cluster Environmental Management System", the Promotion Committee, on a voluntary basis, provides the local SMEs with many resources and procedures that can be shared and collectively exploited at the cluster level. For instance it provides organizations with continuously updated guidelines and indications on how to identify and have access to the applicable legal requirements related to their environmental aspects (e.g.: a legal requirement register was published, including a list of relevant sources, periodical updates on newly introduced laws and requirements, etc.) and to determine how these requirements apply to their environmental aspects.
The **last step** concerns external communication initiatives and tools. By means of these initiatives and tools, interested parties, stakeholders and general public are continuously informed on significant environmental aspects, policy, programmes, objectives and targets, activities and resources for environmental management in the cluster and how these change over time. The relevant information is provided by means of an environmental report concerning the whole area or cluster.
As we above-mentioned, the cluster approach developed in some Italian experiences could be an useful tool to overcome the difficulties of SMEs in the adoption of EMAS and ISO 14001 and, therefore, to enable SMEs to use these EMSs for improving their legal compliance. Partnership approaches among SMEs appear to be highly successful, combining the respective expertise of both public and independent organizations, but are rarely applied effectively owing to lack of initiative, coordination and incentives. EMAS registration has proven its effectiveness in improving the environmental compliance of the local SMEs, as ascertained by the European Commission (2007). In particular, the "cluster approach" has shown that some of the key-elements of EMAS can be further developed and strengthen in the territorial dimension, so to empower the local small and micro companies' capabilities to effectively and efficiently manage environmental issues and, consequently, guaranteeing compliance. In the most recent years, many experiences concerning the so-called "cluster application" of EMSs have been carried out in Italy. Some of these initiatives originated by EU-funded projects (e.g.: "PIONEER" Life project, "ESEMPLA" Interreg III C project – subproject ECOSIND, PHAROS Life project, "SENOMI" Life project in Lombardy) and others have been financed by Regions (ISO 14001 for seaports in Liguria, EMAS for the chemical district in Lazio, EMAS cluster of tannery district in S. Croce sull'Arno). Local initiatives have been carried out, too. Many industrial clusters have been engaged in experiences concerning the implementation of a "cluster approach" to Environmental Management Systems and proved that these can be an effective way to promote, carry out, diffuse and strengthen legal compliance among SMEs. Some of them already achieved a sort of "cluster based" certification/registration promoted by the Italian government by means of the EMAS Competent Body ("EMAS APO" by the Italian EMAS Competent Body) others are still developing this path. Actually, the industrial clusters that obtained EMAS "cluster

registration" (EMAS APO) in Italy are: the Chemical cluster of Ravenna (Emilia Romagna Region); the Chair District of Livenza (Friuli Venezia Giulia Region); the Agropastolar cluster of Nuoro (Sardegna Region); the Tanning District of Vicenza (Veneto Region); the Ham production cluster of San Daniele (Friuli Venezia Giulia Region); the Dolomiti National Park – tourist cluster of Belluno (Trentino Alto Adige Region) and the Paper industrial cluster of Capannori (Tuscany Region). Many SMEs operating in these clusters achieved individual EMAS registration thanks to the support provided by the cluster common resources and support initiatives, described in the previous paragraph.

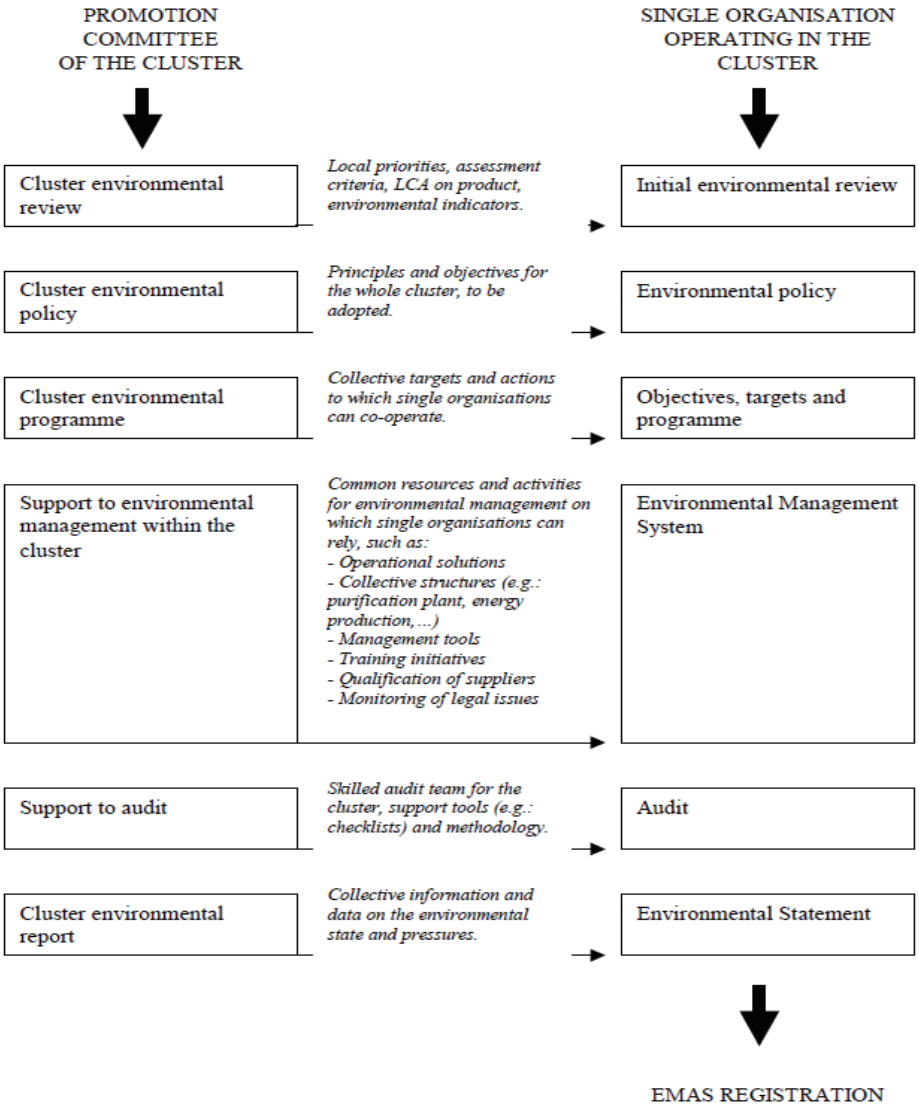

Fig. 5. Methodological steps of the cluster approach (Source Iraldo & Frey 2007)

Among these experiences, one of the most innovative has been the paper-producing territorial cluster of Capannori (Province of Lucca). This Cluster developed its cluster approach thanks to a Life-Environment project, the PIONEER project – "Paper Industry Operating in Network: an Experiment for EMAS Revision", completed in May 2006. The methodology of the PIONEER project encompassed the implementation of the different steps foreseen by the EMAS Regulation at the cluster level, so to create a common basis for tackling the local environmental problems and supporting all the individual organisations operating in the cluster that intended to use collective resources to achieve an individual EMAS Registration. The project produced interesting results in terms of a high participation in EMAS by a relevant number of organisations (22). Many tools have been developed during the project to facilitate the adhesion to EMAS of the SMEs. An example is the "register of environmental legal requirements", applied to the companies located in the cluster. Each organisation can download the register for free and use it as a part of its own EMS. In this way the SMEs have a facilitated access to the management of environmental compliance. Furthermore, many training initiatives are carried out in the cluster to improve the capacity of the local organisations to effectively manage environmental issues and comply with the relevant legal requirements.
At the international level, an interesting initiative is the Swedish "Hackefors Model". The initiative was developed by a private company, Altea AB, which firstly applied it to the district it belonged: the Hackefors district. The target audience is a cluster of SMEs. Usually, participating companies belong to the same sector of industry or to the same company group. The model originated in the Hackefors industrial district in Sweden in 1997 and is a network approach to EMS implementation. All participating companies appoint an environmental manager; together these form the EMS group. From this group a steering committee is selected and a central co-ordinator appointed. The co-ordinator is responsible for the network and the common parts of the EMS, including common documentation. The co-ordinator acts as a hired and shared environmental manager of the group. A motivated and well-trained co-ordinator appears essential for the success of the approach. Each SME develops its own EMS, although a large part of the documentation is identical for all companies (the EMS manual). Centralised handling and steering of many of the EMS documents saves the SMEs much of the administrative work. The approach involves monthly meetings with "homework", training for environmental managers and employees as well as dedicated enterprise visits. This model has been reproduced in 40 different clusters in several other Swedish regions, and in 2004 the number of firms being certified to ISO 14001 as a result of this model were 600.

7. The new EMAS Regulation: opportunities and incentives for SMEs

By publishing the Regulation of the European Parliament and of the Council 1221/2009/CE in the Official Journal on 22nd December 2009, the Community institutions have complied, in extremis, to the public commitment taken on many occasions to complete the second review of EMAS by the year 2009. The new Regulation expressly repeals the earlier 761/2001/EC (EMAS II), but also the Commission Decision 2001/681/EC, which contains guidelines for its implementation; the Decision 2006/193/EC laying down rules on the use of the logo, as well as two accompanying Recommendations (2001/680/EC and 2003/532/EC) thus summarizing the official text of all the requirements for its implementation.

The Regulation, called EMAS III, entered into force on 11th January 2010, becoming immediately binding in its entirety and directly applicable in the Member States. A transitional period is envisaged, according to which the organizations that have registered based on the 2001 Regulations will continue to figure in the EMAS register. Therefore, since the next check expected the verifiers should assess if the organizations registered comply with the new requirements. If the verification of a registered organization is expected before 11 July 2010, the date may be extended for six months, by agreement between the environmental verifier and the competent bodies.
However, a so strict system determines the demand for registered organizations to know and apply in the shortest time possible the innovations provided by EMAS III. For a correct interpretation of the innovations introduced by the new Regulation, it should first be understood that it meets targets for significant expansion of the numbers of EMAS, on the one hand, and to strengthen the credibility and the guarantees offered by the registration, on the other.
According to the preliminary studies (first of all the "EVER Study - Evaluation of the EMAS and Ecolabel for their Revision), it emerged the failure to achieve the potential of the scheme especially in terms of its circulation, with reference in particular to difficulties of adherence by the organizations of small and very small size, and to the lack of advantages and benefits arising from the application of EMAS.

7.1 Simplification for small organizations

As anticipated, one of the main objectives of the review process has dealt with the enlargement of the number of the adhering organizations . To achieve this, the changes introduced were designed primarily to break down the barriers to registration for the organizations of small dimensions which, notably, represent a majority target than larger enterprises (SMEs account for 99% of European companies and generate 57% of value added products).
A major change concerns the duration of certificates and the frequency of audits for SMEs. Article 7 provides that a small organization may require the competent body to extend the maximum period of three years of registering up to four years, and the annual frequency of surveillance for up to two years provided that the verifier confirms that they have complied with the following conditions:

- There are no significant environmental risks;
- The organization does not plan significant changes (see previous note);
- The organization does not contribute to significant environmental problems at local level.

Small organizations could thus reduce the regular audit by the accredited verifier from 4 (3 "monitoring annual" checks and 1 renewal) to 2 (1 'annual monitoring' verification and 1 for renewal), with consequent and significant cost savings.
We wish to underline, nonetheless, that small organizations receiving the extension must prepare and submit annually their updated environmental declaration, although not validated, to the competent body.
The new Regulation also proposes specific recommendations to monitoring small organizations, providing, under art. 26, that the verifier should accept exemptions and exceptions to the conventional structure of an environmental management system based on written procedures and formalized organizational procedures, enhancing rather typical

aspects of the realities of smaller businesses, such as: direct communication and informal multifunctional staff (who covers more functions, environmental and otherwise), training provided through coaching in the workplace and, above all, limited documentation.
Other simplifications for SMEs are encompassed as support and incentives, as treated below.

7.2 Environmental management system requirements

The new Regulation aims EMAS registration as a culmination of a journey towards excellence in the field of environmental management, against which other forms of certification may represent intermediate steps. There are many innovations that realize this vision.
First, the EMAS III continues to be based on the environmental management system introduced by ISO 14001, but complements specifically a distinctive set of requirements, starting by strengthening the mechanism to ensure compliance with environmental legislation.
The attention towards this aspect emerges promptly in many aspects of the new Regulation. Article 2, for example, defines for the first time compliance with regulatory obligations, such as full implementation of the obligations applicable to the organization being certified, including the requirements contained in permits. Furthermore, it clarified that the initial environmental review (no longer occasional, but explicitly referenced in the text as a compulsory part of the EMAS registration) has to provide not only a comprehensive framework of obligations under applicable law, but also describe how the 'organization works to ensure compliance. The Regulation states that organizations submit material or documents certifying compliance with all applicable legal requirements in environmental matters.
The focus on regulatory compliance is also apparent from the requirements of the duties of the Internal Auditor, among which it is particularly emphasized the need to assess the management system for compliance, and also compared to the policy and the organization's environmental program in relation to the applicable legal requirements. It then explicitly states that the internal audit must be designed to also respect the laws.
The continuous emphasis on ensuring regulatory compliance of the EMAS applicant organizations has led the author of the new Regulation to include all over again the "legal requirements and limits of the authorization" even in the non-exhaustive list of environmental aspects to be considered in the EMAS process. See Annex I, Section 2 (in addition to the use of additives and processing aids, as well as semi-finished). It is clear that such integration is dictated by the Commission's desire to emphasize the importance of compliance itself, rather than the idea that this really represents an environmental aspect, an aim which is methodologically misleading with respect to the same definition of the feature ("Element of the activities, products or services of an organization that has, or may have an impact on the environment"). The presence of regulatory burdens, however, can and should reasonably be used as a criterion to assess the significance of a particular aspect (such as, moreover, indicated in Annex I, Section 2), and to understand how to handle it (think of the requirements contained in permits to emissions into the atmosphere or to the regulatory provisions relating to waste).
To counterbalance the considerable effort required to organizations in terms of concrete security and sustaining regulatory compliance, art. 32 of the new Regulation introduces the request to Member States to offer assistance in fulfilling their regulatory obligations, in terms of ease of access to information related to these obligations, and activation of

communication channels (e.g. to obtain clarification) among the organizations interested in EMAS, and the authorities responsible for such obligations. This role can be played directly by the competent organizations or other entities of support appropriately identified by Member States.
In this respect, there is an immediate connection with the Program of Assistance to regulatory compliance for SMEs (ECAP) of the European Commission, that as a curious sleight of hand, indicates precisely in the EMAS one of the most effective tools to support small organizations in keeping up to date on (and fulfilling) legal requirements.
With regard to new management system, there should also be noted that the new Regulation combines in a single annex (Annex II) system requirements derived from ISO 14001 and the additional information which the organizations implementing EMAS should take into account (previously included in an annex), thus improving the effective integration and, at the same time, highlighting the distinctive characteristics of the EMAS process.
In addition to the role played by the initial environmental analysis, and to importance for regulatory compliance, for continuous improvement and widespread communication and transparency (as hereinafter specified), Annex II gives special attention to training and to the involvement of the organization's personnel, whose active participation continues to be a prerequisite and a vital resource, both to the functioning of the system and to improving environmental performance.
By this logic, as well as extend the provisions contained in the former Annex IB, Section 4, the new text makes it, in fact, mandatory part of the guidelines related to participation of employees as part of EMAS, as already suggested by the Recommendation 2001/680/CE .
The innovations quoted above are accompanied by brief clarifications on the environmental management system, that is in its practical implementation by many verifiers throughout the EU were well established by experience (which probably inspired changes to the Rules). Just think of the need in view of the first registration, to plan and launch, but not to complete, an audit program (at least about the most significant environmental impacts), and to make at least a review of the leading role.

7.3 Reference documents

An important innovation in introducing EMAS III regards the reference documents, being documents that describe best practices for environmental management that is, the most effective means by which an organization may apply a management system able to produce the "best environmental performance in specific economic and technical conditions", besides those indicators that best measure these benefits in a given sector. The Commission will develop these reference documents, with the primary objective to promote the homogeneous implementation of best management practices.
The use of reference documents is not compulsory but, if available, organizations should at least take into account what they reported, both in the deployment of their management system, and in preparing the environmental declaration. Besides, the verifiers are also required to use them as a benchmark to evaluate the effectiveness of a system, especially for the evaluation of the organization's environmental performance. These facts show that organizations may well justify a failure to properly align to what has been reported in the reference documents applicable to their business sector.
Originally, in the intention expressed by the European Commission in the "Explanatory Memorandum" (the strategic lines of the revised EMAS), the reference documents should be

also "intersectorial" and refer to the methodological and operational aspects of the scheme under further consideration. This would fill some obvious gaps of the new Regulation, and to provide guidance that, although expected by many, it is in fact ignored.
Consider the issue of "indirect" environmental elements, very complex for some sectors, which EMAS III offers only a confirmation about approaches already established in the practice implementation of many Member Countries. On the one hand, the regulation confirms the interpretation that the indirect aspect is what "comes from the interaction of an organization with third parties", and that it can be "influenced by them, to a reasonable extent". However, it also demands that the same organization assesses the significance of this aspect, by considering how much influence it can exercise on them .
On the other hand, it simply states that for those organizations that are not part of the industrial sector, as local governments or financial institutions, it is essential that they consider the indirect aspects related to their main activity and, that in this case, an environmental analysis and management procedures limited to its structures, are absolutely insufficient.
Another aspect on which much is expected, especially after the enactment of Guide Lines in 2005, regards the integration of the EMAS management system with the size of products and of services belonging to an organization. On this issue, innovations compared to EMAS II are almost untraceable: we find evidence about the size of the product among the skills that auditors should have, while it is reported verbatim the "life cycle" between the indirect aspects of Annex I and, finally, in the group of elements to consider when evaluating the significance of environmental aspects we have the following: design, development, manufacturing, distribution, maintenance, use, reuse, recycling and disposal of products of the organization.

7.4 Tools and incentive mechanisms

Innovations that relate more directly to implementing the requirements of EMAS by the organizations concerned, have been accompanied also by a set of important changes introduced by the new Regulation concerning the role and responsibilities of others actors involved in the scheme: the competent bodies, the States, verifiers, etc.. From an in-depth reading about the innovations planned for these subjects, it emerges that some actions (under their responsibility) that could have very positive implications on individual organizations. It is essentially a set of measures of support, encouragement and promotion of EMAS, aimed at increasing membership to the scheme to facilitate and make more obvious and tangible benefits associated with certification. See Table 3 for a more detailed examination of these measures, in the following paragraph we simply highlight some of the main keys issues.
First, the review clearly shows its intention to "empower" the Member States concerning the initiatives to support EMAS: from the request to introduce incentives for certified organizations, such as access to funding or tax relief (although it is advice able to link it to the ability to demonstrate a real improvement in environmental performance by the beneficiaries); to the obligation to develop and implement ways to simplify legislation for certified organizations, to the full enhancement of EMAS in terms of legal rules, control and management of tendered contracts and public procurement.
Second, a series of innovations designed to encourage and facilitate the completion of the course EMAS, relying on other forms of interim certification or feeding it through cooperation and networking.
On the one hand, the Regulation requires Member States to propose a staged approach to organizations, and initiates an interesting procedure for the recognition by the European

Commission (on proposals of the Member States themselves), of "other" systems of environmental management in conformity, in whole or in part, to the requirements of EMAS. If the European Commission will recognize the equivalence between "another" system of management (national or regional) and the new Regulation, the organizations that already adhere to (and that are certified in accordance with) it, should not refer to the relevant requirements of further verification, because they will be automatically considered compliant in the first EMAS registration.
On the other hand, the new Regulation proposes the approach, also known as "Cluster EMAS", which was developed mainly in Italy, thanks to considerable supportive work by the Committee Ecoaudit-label, of Apat (today Ispra) and by the Network Descartes/ CARTESIO (promoted by the Regions Emilia Romagna, Lazio, Lombardy, Liguria, Sardinia and Tuscany). Once more, however, there are positive and negative aspects of it: although there is a recognition of the effectiveness of the cluster approach (which in the Italian version is translated as the more restrictive term of "districts"), and the request to Member States to encourage its development, it should be noted that it is not expected to be a real cluster registration (as it envisaged the Explanatory Memorandum), thus in the text are missing those useful, albeit meager, operating instructions introduced in the Decision 681 / 2001/EC that has been repealed.
As already noted, this type of methodological shortcomings may eventually be filled by specific reference documents.

8. Conclusions

In the authors' intention this paper represents the attempt to identify solutions, tools and incentives for SMEs to overcome constraints and difficulties they experience by implementing an EMS. Removing potential barriers and reinforcing economic incentives should be main targets in order to allow for a wide diffusion of EMS among SMEs.
Some methods and possible instruments have been dealt with in this paper: working by group seemed to be a good way to diffuse information and to share implementation costs; technical, organisational and managerial support given by local actors (local governments, trade associations...) is to be considered very useful to effectively help smaller enterprises; training courses for managers and technicians were very precious in deepening the environmental awareness within companies; the publication of handbooks, guidelines and manuals, seemed to be generally appreciated by firms.
The further development of environmental management schemes (like EMAS or ISO 14001) is going to play a crucial role in stimulating and favouring the implementation of EMS by small enterprises. To this purpose, it was useful that the new EMAS Regulation has include measures aiming at facilitating and simplifying adhesion by SMEs, taking into account their specificities and needs described above.
The increased adoption of EMS between SMEs highlights as the achievable benefits are overcoming the initial obstacles that make this tools hard for organizations with small dimensions. The awareness of own environmental impact and the compliance with environmental regulation represent the main results achieved by means of an EMS.
On the contrary, the analysis emphasizes that there are some factors that make a SME fitter than others to adopt an EMS: for instance the level of internationalization, the position on the supply chain, working in industrial sector with significant environmental impacts and so on.

Which further initiatives could be should be requested to policy maker for fostering and facilitating the diffusion of EMS among SMEs?
According with the findings emerged in the literature the most successful activities would certainly be:

- technical support to SME personnel
- financial support and/or economic incentives for SMEs
- simplification of EMAS (and ISO 14001) requirements and/or guidelines targeted to SMEs
- training initiatives for SME internal personnel
- possibility for a whole homogeneous industrial area (e.g.: an industrial district), and not just for a single enterprise, to obtain an environmental certification

Another interesting tools refers measures for favouring networking and co-operation and methods and tools for measuring, evaluating and comparing environmental performance.
The last suggestion deserves a final comment. Many SMEs showed the opportunity of identifying common environmental performance indicators (EPIs), so that firms can use them to select and measure their most significant environmental effects. In fact, many firms are familiar with legal compliance as the only environmental performance indicator. Moreover, the development of indicators for measuring the environmental, organizational and managerial performance of the environmental management systems could help verifiers in evaluating enterprise capacity to achieve continuous improvement of their environmental performance. This could give an answer to the general concern regarding the potential diversification of criteria used by verifiers and certifiers in analysing environmental management systems.The development of EPIs could also support the definition of best available technologies for each industrial sector: this is an important goal in the perspective of the implementation of the IPPC directive.

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2

Environmental Waste Management in Construction Industry

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1. Introduction

The successful development and implementation of system thinking and processes innovation in an organizational system can produce a significant saving in the amount of business and environment resources and therefore a smaller environmental impact. It is not just about environment resource consumption, production units, but also about the improvement of economical efficiency and thereby the increased competitive capacity of organizational systems. At the same time, the aim is to reduce harmful substances into the environment, the enhancement of relations between organizational systems and social responsibility and thereby the associated standing in the wider social environment (Mulej, 2004). For this reason the care for processes innovation, the change of relation to the environment also the consequence of knowledge about the meaning of co dependence and creative collaboration to achieve the safe, environment friendly operation. Sustainable development is so the consequence of innovation's administration and processes in sense of consideration of dialectic system of viewpoint (Kralj, Krope, Goricanec, 2005).

2. The chosen problem and viewpoint of treating

The production cycle has been permanently shortening; prices, dates and certainly the products quality are more and more under big pressure. The task of management is directed to the change of organizational structure, processes, culture, to compete equivalently with the concurrence on the purchaser's market. The qualities of standards, known by name of ISO 14000, dictate the new measurements in the operation of organizational systems. But the confederation of certificate ISO 14000 do not finish activities on the domain of environment treating, but it is only the further stimulation for the activities on the way to the whole master of quality. The activities are not orientated only to technical-technological problems or just to participants as creators of treating with environment, but to the whole proceeding. In a world where markets, products, technologies, competitors, regulations and even societies change rapidly, continuous innovation and have become important sources of sustainable competitive advantage.
Because of co dependence is the management quality and treating with the environment directed to the quality of administration and leading, because the quality is the essence of organizational culture of creating collaboration. It is about more points of view and inter

structural treating of mastery of administration, that results from co dependence of different systems of quality (not only technological treating) and that's why the whole measurement of management.
The permanently change of demands to changing the enterprise's practice, that is a consequence of the market competition, it dictates to the management the stimulation of the internal enterprise and the whole solving of problems. It is possible to conserve the preserve advantage especially with the entireness between the planning, administration, supervision and comprehension of content of entrepreneur's activity. The totality of treating of the quality mastery is so a challenge to the entrepreneur's management and the possibility for the reputation strengthening of management. The domain of the ecology is a very sensitive domain of the whole treating. The environment protection is consequently the result of non-systematic, non-entirely and non- inter-disciplinaire, non- qualitative measurement to the planning and defining, that means in the content of administration. For this reason the care for environment, the change of relation to the environment also the consequence of knowledge about the meaning of co dependence and creative collaboration to achieve the safe, environment friendly operation. The responsible holder of dialectic, between different points of view, entire measurement are the administration workers of business systems that is management. The experience of past was too much orientated only to the intensity of qualitative, specialized production, without consideration of influences on the environment and this does not enable the conditions for the ecological innovation. Only the whole, inter-structural and different point of view operation of organizational system enables the treating of ecology and permanent development as an important component of all essential viewpoints in the administration. The permanent development is so the consequence of innovation's administration in sense of consideration of dialectic system of viewpoint.

3. European Union Environmental Policy

European Union Environmental Policy followed these steps:

Date	Key Developments
1967	Council of Ministers adopts Directive 67/548/EEC on dangerous substances
1972	EC Heads of State and Government adopt formal environmental policy at a Paris Summit meeting, following Stockholm UN Environmental Conference
1972-1987	Despite lack of provision for EC environmental action in EC Treaty, more than 100 legal instruments are adopted.
1972-1976	First Community Environmental Action Programme addresses prevention and "polluter pays" principles as well as EIA and co-ordination of national policies.
1977-1981	Second Community Environmental Action Programme with heavy focus on waste issues.
1982-1986	Third Community Environmental Action Programme. Emphasis on integration of environmental issues into other areas e.a. transport, energy and agriculture.
1987	Single European Act (SEA) amends the EC Treaty and states the objective of achieving a "single market" by 1992. SEA explicitly mandates EC environmental action and the need to reconcile trade and environment. SEA also establishes "subsidiarity principle" i.e. actions should take place at the lowest regulatory level.

Date	Key Developments
1987-1992	Fourth Community Environmental Action Programme with focus on air pollution, water quality, chemicals and nuclear safety.
1990	Maastricht Treaty on European Union adopted . EC changed to EU and Community authority in environmental policymaking is further expanded. Member States may be granted temporary derogations from EC environmental rules and/or financial assistance in implementing them.
1991-2000	Fifth Community Environmental Action Programme adopted "Towards Sustainability". Close similarities to Agenda 21 developed at the 1992 Earth Summit. Focus on integrating environment into other policy areas, e.a. industry, energy, transport, agriculture and tourism. Actions target all environmental media (air, water, waste). Economic and fiscal instruments also proposed.
1993	European Environmental Agency (EEA) established.
1997	Treaty of Amsterdam – amends Maastricht Treaty and the Founding Treaties. Further expands environmental protection and sustainable development components.
2000-2001	Sixth Community Environmental Action Programme under development.

Table 1. EC Environmental Policy (PriceWaterhouseCoopers, 2001)

Organizational objectives, policies, and plans are not mutually exclusive components of the management process. They are highly interdependent and inseparable. One cannot effectively pursue objectives without first knowing what they are and what policy guidelines must be followed. The importance of clear and sound objectives cannot be overstated. As the old saying goes, " If you don't know where you're going, any road will get you there'.

4. Management and ethics

Ethics are principles of conduct used to govern the decision making and behaviour of an individual or group of individuals. Because management is concerned with making decisions within an organization, the ethics of the individual or group of individuals making these decisions have significant implications for the organization's stakeholders, its employees, customers, shareholders, suppliers, government, and the public at large.
Special are ethics principles important in environmental management system. Organizations of all kinds are increasingly concerned with achieving and demonstrating sound environmental performance by controlling the impacts of their activities, products and services on the environment, consistent with their environmental policy and objectives.. They do so in the context of increasingly stringent legislation, the development of economic policies and other measures that foster environmental protection, and increased concern expressed by interested parties about environmental matters and sustainable development. Ethics principles covering environmental management are intended to provide organizations with the elements of the following philosophical approaches: justice, individual rights and utilitarianism. The principle of justice involves making decisions based on truth, a lack of bias, and consistency. The principle of individual rights involves making decisions based on protecting human dignity. Finally, the principle of utilitarianism

involves making decisions directed toward promoting the greatest good for the greatest number of people (Mulej, 2004).
The role of ethics in management decisions is difficult, partly because it is such an emotionally charged issue and partly because of the many and varied ethical problems faced by mangers.

5. Organizational culture represents an ideology of the organization

Organizational culture represents an ideology of the organization as well as the forms of its manifestation. The ideology of the organization includes beliefs, values and norms. It is manifested through symbols, language, narration and other activities. Organizational culture is the set of shared philosophies, assumptions, values, expectations, attitudes and norms which bind an organization together. It helps a company to implement its strategies effectively (ISO 1401:2004(E), 2004). Organizational culture has been defined as patterns of shared values and beliefs over time which produces behavioral norms that are adopted in solving problems (IWA 1:2005 (E), 2005). Schein (Shein) has also noted that organizational culture is a body of solutions to problems which have worked consistently and are therefore taught to new members as the correct way to perceive, think about, and feel in relation to those problems. Cultures basically spring from three sources, (1) the beliefs, values, and assumptions on founders of organization; (2) the learning experiances of group members as their organization evolves; and (3) new beliefs, values, and assumptions brought in by new members and leaders (ISO 9001:2004(E), 2004). In fact, these shared philosophies, assumptions, values, expectations, attitudes, and norms bind an organization together. Organizational culture can therefore be used as a form of control (Wilkins & Ouchi, 1983) and as a means of increasing productivity (Denison & Mishra, 1995).In sum, organizational culture is glue that welds managers together for effective implementation of organizational strategies, and the absence of this glue would bring about disastrous effects on the organization.
A knowledge-era organization needs to cultivate opposing traits and embrace dualities. The effectiveness of organization learning depends on how knowledge management processes are aligned with an organization's infrastructure and processes, in a manner that supports the achievement of an organization's goals. That knowledge is of fundamental importance for organizations of any sized industry is no longer a question. Even if knowledge is not the sole element for an organization's survival, it is the most important one because it supports all others.

6. Modern trends requiring systems thinking

There are several trends in world-wide life requiring systems thinking, such as:

- United Nations are the widest organization of humankind and exist to work for holism in detecting and solving of the world-wide problems;
- Many other international organizations exist for the same basic reason;
- Sustainable Development is an important concept, which humankind has launched through United Nations and several other international organizations in order to solve the problem of survival of humankind: we all need interdependence of both our care for economic development and for nature, because both of them together, in synergy rather than in separation, support our survival;

- Since the times of enlightment several centuries ago, humankind has been working for its economic development, including its development knowledge, including science and its application; this development resulted in enormous amounts of new findings, discoveries, and innovations, as well as in a more and more narrow specialization;
- The unavoidable specialization has become exaggerated: along with deep and crucial insights it has caused many oversights, resulting in small and huge problems, all way to world wars, many other wars, profit (as motive) killing profit (as outcome) by causing huge medical, reparation, nature renewal, etc. costs; all these trends required and require increasingly the international bodies and actions mentioned above under the motto: Think globally, act locally ("Glocalization");
- Science and its application resulted, among other effects, in humankind's capacity to master more and more complex, not only complicated, issues, all the way to the most modern computer-supported tools (1) able to bring data, messages, even information from other planets that are many million kilometers away from Earth, (2) able to enter human body, (3) cure diseasies as never before, etc.
- Etc. Most of the amaising results of modern times result from combinations of
  - Deep, and hence one-sided, specialization, and
  - Bridges for co-operation between mutually different and interdependent specialists, based on application of (informal or formal) systems thinking.
- Systems thinking, rather than systems theory, is a millennia old practice of the successful practitioners and scientists and artists, which has made and makes them different from the less successful ones. (All losers are more or less one-sided thinkers and actors.)
- The exaggerated specialization of the modern times caused the need for systems thinking to receive support from systems theory. It can teach humans to live consciously in the way that has always made a part of humans successful without possessing a theory as their background of their success.

(For details see: Dyck et al, 1998; Mulej et al., 2000; Mulej, 2004; Rebernik et al, 2004; etc) (Mulej, 2004).

In the 19th century, there were authors claiming the humankinds' need to consider relations, interdependences, not parts of the world as independent entities only. Their background may have been consciously or subconsciously the ancient Chinese notion of interdependence called yin and yang, and/or the ancient Greek notion of interdependence called dialectics. Both mean interdependence. In the 19th century one has seen Idealistic Dialectics, Materialistic Dialectics, and several more notions and teachings about holistic thinking (Mulej, 2004).

Humankind's knowledge has been growing tremendously, and has been causing an increasingly narrow specialization into single parts of knowledge, with very rare and poorly developed habits of interdisciplinary co-operation;

7. Innovation of administration - the stimulation of ecological innovations

The production concept under the influence of quick and unceasing changing environment adapt to the selection of consumer's needs and wishes and first of all to response to those claims, that are supported with purchasing power. In order to explain this viewpoint, shall develop a systemic model of individual human beings, showing how our co-evolution with our environment is linked to our thoughts, emotions and actions (Pregrad, Musil, 2001). In

the coming years the relationship to the environment will be the key component of competitive ability. The informed individual will influence on the professional dynamics in collaboration with others that will claim the strategic reflection and acting. Because of mutual co independence, cognition of creative collaboration's urgency between all in the process of protection included subjects, above all responsible administration holders, the claim for the change of leading style will be of priority nature. The role of leadership is so directed to the change of starting points of professional philosophy.

One point of view of administrative measurement is substituted with many points of view, inter structural creative collaboration. The environment protection and permanent development is a complex process, where the earlier events have more influence than the later one. From here it originates the sense of activity planning of these, who administrate, who define the aims, who organize and so on. The inadvertence of independence between the parts of totality, that's why also synergic characteristics of the totality, which parts do not have as an individual part, it leads to simplification, that has in case of environment protection the catastrophic experience. Experience show that the environment protection and permanent development as a part of entrepreneur's philosophy is not carried into effect enough; this is so because of administrative workers, who were used to make decisions independently without collaboration of other experts. Without participation of everybody in the chain sequence and from here resulting co dependence it is not possible to expect the good results. The partial solution gives the partial results. The law about the hierarchy sequence and co dependence brings the cognition that it happens more or less all in life in nature and in creating in processes, in which the earlier events have more influence than later one. Consecutive (direct and indirect) influences of parallel events, but they interweave because they more or less depend on one from another (= coindependent) (Mulej, 1992). The starting point of environment protection is in the hands of changing of directed management. Change, innovation, administration are the basic starting point, because such innovation becomes a composed part of the professional politics and the way of operation. The relationship between management and innovation is the element of strategic direction of professional system. The business system is not isolated from the environment, but it is co indedently interweaved with other business systems, that's why the environment protection and permanent development are also results of social environment. The systemic reflex ion with the administration is necessary (Mulej, 1992). System/whole way of reflex ion

- Co dependence, relationships, connection, openness, dialectic system of view points,
- Complication of kind complexity (and kind complication,
- Attractors (attracted, influential powers),
- Emergence, originating of new characteristics of totality, which parts alone do not have,
- Synergy, system, synthesis, new totality with new characteristics
- Totality, entireness, a big picture inclusively with details, characteristics of parts and connections and their consequences,
- Networks, mutual influences main subject of reflex ion.

No system/old way of reflexion:

- Independence, dependence, unconnection, closure, only one point of view,
- Simplicity or complication of complication alone,
- Isolation without attracted, influential powers,
- New characteristics, which would be consequences of relationships between parts in a totality, do not come into existence.
- Parts and partial characteristics as the only one, analyses without synthesis,
- Mutual influences outside attention of reflexion (Mulej, 1992).

Innovation is necessary on all domains and everybody is included in innovation. The role of management is shown in creativeness for the support of collaborators' creativeness. The administrative innovation is so a segment in the innovative business system. From collection of the individual knowledge it comes to the system that is based on interstructural creativeness co dependent on collaboration of different branches. The administrative innovation is a result of team - projected work, supported with continual education of all collaborators in the company, from the basic to the highest hierarchic level and with continual changes in the sense of improvements. The supported leading stimulates collaborators to the responsible behaviour and so it influences on the business system as well as on ecological system. In the example of environment protection it is necessary that we are as much collaborative, creative and target directed as possible. The aims follow the basic and operative:

- The permanent preservation of vitality of nature, biological variety and autochthonism of biotic sorts, their habitats and ecological balance,
- Preservation of variety and quality of natural goods, natural genetic fund and preservation of ground fertility,
- Preservation and renovation of variety of this culture and aesthetic value of region and natural valuable nesses,
- Decreasing of natural sources use, substances and energy,
- Gradual transition to the use of renovated natural sources,
- Prevention of danger and decreasing of charges on the environment,
- Abolition of environment harm and repeatedly
- Restoration of regenerated abilities.

To the purpose of environment preserving development, the aims of environment protection are also:

- Changes in production and samples of use, that contribute to the minimization of natural sources use and creativeness of waste,
- Development and use of such technologies, that decrease and suppress environment charges,
- Use of harmless and decomposed chemicals and substances that have not been accumulated in alive organisms.

The dynamic creativeness of administration is important with the realization:

- Dynamic creativity management has its field of application as an approach for handling complex problems, i.e. as a supporting tool in the process of attain sustainability.
- The whole process of creative problem solving -logical-analytical procedures based on convergent thinking as well as creative intuitive procedures based on divergent thinking.

The whole process of creative problem solving is a complex system in itself, dynamically changing over time, with permanently interacting system elements, it requires a systems thinking perspective in order to be understood and applied (Mulej, 1992).

8. Care for company- care for environment

The pressures of high technical market economy direct the business systems to the continual change and adaptation of quality level of operation to the level of consumer's profit. The inquiry for new products requires the improvement of administration measurement, to give up obsolete technologic products, procedures, personal and organizational culture, and so on. It is about two basic facts about the new period:

1. Things have been changing faster every day.
2. People are more and more different one from another.

Characteristic for these most developed is the effectiveness and successfulness, that basis on the price, quality, uniqueness and choice of tendered. It is about the enforcement with the knowledge, creativeness, culture, where in its broadest meaning belongs also the permanent development and environment protection. In the near future the professional systems will be estimated and compared, they will compete also with it. Today many enterprises still compete with the environment unkind products and technological instruments. The care for the enterprise dominates over the environment protection. To consider those before us means to achieve also the level of environment protection quality. The ability of competition with the world competitiveness also means the ability of competitiveness in the permanent development and environment protection. It is possible to preserve the competitive advantage especially with the totality between the planning, administration, control and comprehension of entrepreneur operation content. The domain of permanent development and dealing with the environment is very sensitive domain of the whole proceeding. The permanent development and environment protection is not only the problem of technology, chemistry, economy, and so on, but mainly and first of all of our values and behaviour, that claims different point of view and interstructural viewpoint. Because with intervention it comes to the natural environment to the bigger connected recurrent consequences, we do still not now many of these, that's why the data about the individual environment component are not enough. We need " the common viewpoint. The care for the enterprise means also the care for environment and permanent development and it is the task of management. For this reason the care for environment and permanent development is the component part of responsibility and obligations of management. The care for the environment and the permanent development depends first on administrative workers and their collaborators on all hierarchic levels. The classical operation, limited on the expectation of competitive success in the mass production is exceeded with innovative operation, that achieve the competitive position with different point of view, interstructural collaboration. To achieve this, it is necessary to influence on the starting point of most influential people in administration and content of administration-deciding. "That's why with system and systematic research and innovation of relationship between the people in the enterprise, who has for consequence also the product or service, it appears with them equivalently the system and systematically innovation of starting point for the individual (professional) deciding, that has for the consequence the knowledge examination, communication and professional label or (entrepreneur's) culture (Mulej, 1992).

The care for the enterprise and so the care for environment and permanent development claim (dialectic) system reflection:

- The creative collaboration enables the use of different viewpoints, so the totality of reality is better realized,
- The specialists are inevitable, but for themselves only partly useful, because they see and consider only that part of reality, that the chosen point of view enables them because of the specialization
- Without collaboration they can not supplement to achieve the synergy, that they can not manage individually, but it is urgent,
- The environment protection is realized more successfully with the system of viewpoints, that many individually creatively enforce them.

The influential co-organizations of permanent development and environment protection can become all collaborators in the professional system, mainly the administrator with the decisiding acting. Similar to the yin that cannot exist without the yang, the core philosophy behind is that for sustainable development the creative problem solving process has to include both:

- Logical, analytical and creative problem solving,
- individual and group achievements,
- vertical and lateral thinking (or convergent and divergent thinking)
- IQ and EI (emotional intelligence)
- extrinsic and intrinsic motivation,
- specialization and holism,
- linearity and circularity,
- structure and deterministic chaos (Mulej, 1992).

In the practice it is seen as an example of indicating of environment friendly products, ability of packaging recycle and so on. In the developed world the development mechanisms are already accepted over those subjects that treat irresponsibly with the environment and so they increase the costs (taxes, duties, loss of reputation, and so on) and they decrease the competitive position. In the framework of European unity a prescription 1836/93 for voluntary ecological judgement of enterprises in industry in the sense of ecological administration and judgement; it came into force in 1995. The decision is in the competence of company guidance. It is about something similar, as the standards prescribe ISO 1400x. In this case it is about the system of administration from the environment protection viewpoint. The enterprises will also have to adapt to such way of public information.

9. Environment protection is a result of guided process

In efforts for the improvement of position on the purchaser's market the companies must also consider accordance of operation with valid environment protected prescriptions. It is about the requests consideration of international standards:

- ISO 14001: System of environment treating,
- EMAS,
- Indication of the environment friendly products,
- Evaluation of politic environment protection execution,
- Life Cycle Analysis LCA.

The inclusion of enterprises in the international market, the care for reputation, that the enterprise profit with the environment protection and permanent development, places the politics of environment protection to the base of the professional politics. The environment protection and permanent development is so a basic component of the basic politics and it is confirmed by the highest administration agency. It is about the important decisions about the basic goals of operating and development. The permanent development and environment protection is a result of deliberated, guided process that begins with the preparation of management and it continues with the changing of administrative processes on all levels. It is about the acceptance of basic principles values and rules. More than constraint of the state, the system is important, that is founded on the volunteer offer and creative cooperation. In the contemporary circumstances the creating of teams is getting most important for the creative cooperation, because they search the opportunities, solve the problems and in the end they take decisions.

The planning of environment protection and permanent development begins with market research, it continues with the preparational functions (development) and so on to packaging, delivery, use and after cessation of life period of the product it comprehends the elimination on the environment friendly way. The role of administrative people on all levels can be seen in direction and guarantee of decreasing or preventives of negative effects of environment protection. The important task is the stimulation of creativeness and innovativeness to achieve aims and interests of professional system and also of purchasers' expectations. In the administrative process it is about giving up of old leading styles, old relationships, old-fashioned leading aims, ineffective organizational structures and introducing of such administrative methods, that support creativeness and innovativeness (Kralj, 2004).The innovative operation is operation that, according to the production and all other its components is found on innovations. That's why the following characteristics indicate it:

- Each cost is basically unnecessary. It gets really unnecessary when we know and want to work in more intelligent way.
- Each product or procedure falls sooner or later out of use. So we must incessantly doubt about all given habits, although we count them (still) for perfect and correct. Otherwise we cannot achieve the contemporary quality of life.
- Everyone is concerned about the quality of life and for this reason (as possible as perfect!) Everyone is also concerned for quality of the whole operation and its all components. That's why we have to develop our brains and activate the creativeness of everyone.
- We should search constantly and everywhere the possible novelties! Only rare of them will become innovations, but without intended search, there will be even less of them, probably not enough.
- For this reason we should work as clever people and not as crazy people (Steiner, 2004).

Just the environment protection and permanent development become our every day's care and more and more numerous people care for the environment we live in. On the domain of environment protection, the sense of co independence and the law about hierarchy of sequences are expressed more distinctively, their consideration leads to the catastrophic consequences (Chernobyl, Sandos, Bophal and so on.).

10. Organizational approach

Survey of literature shows that there has been no research about innovation in production processes in manufacturing enterprises in transitional economise. Everybody speaks of technological development only, although it is causing increasing unemployment around the world and other problems such as motivation and environmental degradation, including a dangerous climate change. There is also an unchallenged supposition that in transitional economies owners and managers are equally fond of continuous innovation as are the ones in the most advanced corporations of the world (Markič, 2003).

The term "innovation" is usually associated only with technology, in the strictest meaning of the word (new)products and new methods for making them. Nevertheless, innovation refers to the process of bringing any new, problem solving idea into use. Idea (as a step on their way to innovation) for reorganizing, cutting costs, putting in new budgeting systems, improving communication, or assembling products in teams are all innovations, provided the new idea is useful in its users's judgement. Therefore, innovations in management

methods and organizational practices constitute a wide range of opportunities for "corporate entrepreneurs" (Moss Kanter 1983: 20-21) as well as for other types of activating employees" ability and motivation (eg. 20 keys method, environmental standards ISO 14001, social accountability standards-SA 8000, safety and health standards OHSAS 18001, TQM-total quality (as well as self-regulation and business excellence) management and other innovation management methods) (Markič, 2003).

In efforts for the improvement of position on the purchaser's market the companies must also consider accordance of operation with valid environment protected prescriptions in field of process consumer. The inclusion of enterprises in the international market, the care for reputation, that the enterprise profit with the environment protection and permanent development, places the politics of environment protection to the base of the professional politics (Kralj, 1994). The environment protection and permanent development is so a basic component of the basic politics and it is confirmed by the highest administration agency. It is about the important decisions about the basic goals of operating and development. It is about the acceptance of basic principles values and rules. More than constraint of the state, the system is important, that is founded on the volunteer offer and creative cooperation. In the contemporary circumstances the creating of teams is getting most important for the creative cooperation, because they search the opportunities, solve the problems and in the end they take decisions.

The current position of an organization with regard to the environment can be established by means of an initial processes, innovative operations and management review. The innovative operation is operation that, according to the production and all other its components is found on innovations. The initial review can cover the following:

- identification of legislative and regulatory requirements;
- identification of processes, innovative operations;
- identification of environmental aspects of its activities, products or services so as to determine those that have or can have significant environmental impacts and liabilities;
- evaluation of performance compared with relevant internal criteria, external standards, regulations, codes of practice and sets of principles and guidelines;
- existing business, processes, innovations, environmental management practices and procedures;
- identification of the existing policies and procedures dealing with procurement and contracting activities;
- feedback from investigation of previous incidents of non-compliance;
- opportunities for competitive advantage;
- the views of interested parties;
- functions or activities of other organizational systems that can enable or impede environmental performance (ISO 14004:1996(E), 1996).

The process and results of the initial environmental review should be documented and opportunities for EMS development should be identified. Such a partial approach can lead to technically and economically inappropriate solutions. The new model which promotes production processes innovation was derived from the model of managing company policy following the interest theory and business excellence. It was conceived in the frame and interdependence of both objective and subjective starting points of initial change agents as well as from process knowledge of process managers. New dimensions like business excellence, production processes innovation, companies" capacities and opportunities for

continuous innovation, as well as values, knowledge, skills and feelings of change agents, will be added to the basic model (Markič, 2003).
Organizational systems or models need lean organization. Lean organization is first step of processes innovation and environmental protection. Possible measures, which the lean organization can encompass, include the fields of organizational measures, reconstruction of existing processes and products, the use of modern equipment and techniques as well as the introduction of new technologies. The dimensions of business excellence, especially production excellence, of production processes renovation, a company's or other organization's capacity to innovated as well as the values, knowledge, skills and feelings of production processes innovation agents, are added to the basic model (Kralj, 2005). The renovation of production processes results from lean organization, which is based on up-to-date technological and organizational starting points. Market need new consumers. Consumers need new products and services. Only innovative lean flexible organization could be the answer. Lean organization is market-driven; a buyer's market and innovation society prevail and acts as change generators in a company or other organization (Markič, 2003). Figure 1 presents an approach to environmental management system integrated with other management requirements.

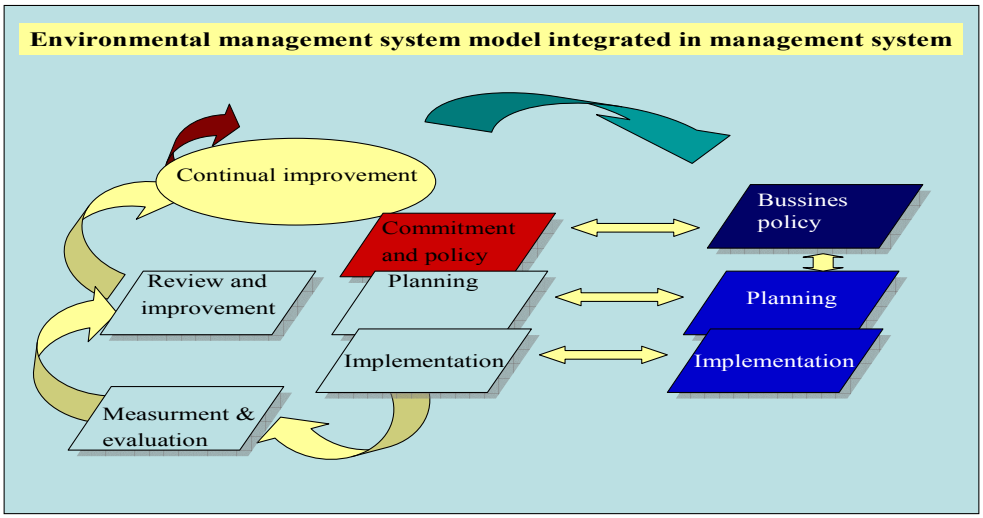

Fig. 1. Environmental management system integrated with other management requirements

11. Processes innovation is a step to environment protection

New economic issues dictate the redefining of economic interests in the wake of the recognition, that the natural environment is a limited production factor and not, as had previously been considered, only the supplier of raw materials. These have previously been free goods without an assigned market value, while the environment has been an agent for the neutralization of wastes and emissions of production and consumption (Steiner, 2004). The integral-orientated mentality represents a deviation from the previously established linear way of thought and activity, which is no longer sufficient in the light of the contemporary complexity of events. However, these one-dimensional elements are soon

faced with insurmountable obstacles. This is why the integration of environmental goals into the system of entrepreneurial policy is so vital. In theory, we can distinguish the ones, which pertain to the inflow (rational use of raw materials, materials, energy, etc.), and those, that relate to the outflow (absolute limitation of waste and emissions), with the simultaneous maximization of waste re-use.
The continual adaptation for enforcement of competitive ability of professional system dictates the stimulation of creativeness, intensity and novelty (Wright, 2004). That's why the state measures and people's habits enable in the innovative society, that it exists and has the supremacy:

- Contemporary e.g. creative democratization in the whole society, all associations and mutual relations,
- Contemporary, e.g. to the tenderness very demanding market and so the authority of innovative instead of skilled workers,
- Contemporary comprehension of ownership, which sense is not the interest for incomes as in the Middle Ages (not " the right to the use and misuse" as in Roman law), but the interest for the competitiveness, inclusively with social profit, on the basis of innovation creativeness,
- Contemporary comprehension of innovations,
- Contemporary e.g. innovative operation,
- Contemporary e.g. innovative enterprise, that is not defined as ownership (of smaller) companies, but as innovative administration of innovation and innovations,
- Innovative society tries today to achieve purposely also with measurements for "the society of perfect quality" (Mulej, 1992).

12. Entrepreneur environmental policy

The environment protection and permanent development is a complex process, where the earlier events have more influence than the later one.
From here it originates the sense of activity planning of these, who administrate, who define the aims, who organize and so on. Experience show that the environment protection and permanent development as a part of entrepreneur's philosophy is not carried into effect enough. The business system is not isolated from the environment, but it is interweaved with other business systems, that's why the environment protection and permanent development with processes innovation are also results of social environment (Kralj, 2005), which based on clearly policy and strategic management process.
International economic practice as well as economic practice in Slovenia, has conformed to ISO 14001 (Environmental management systems – Requirements with guidance for use), as the role of these standards is raising levels of environmental management in business. Top management shall define the organization's environmental policy and ensure that, within the defined scope of its environmental management system, it:

a. is appropriate to the nature, scale and environmental impacts of its activities, product and services,
b. includes a commitment to continual improvement and prevention of pollution,
c. includes a commitment to comply with applicable legal requirements and with other requirements to which the organization subscribes which relate to its environmental aspects,
d. provides the framework for setting and reviewing environmental objectives and targets,

e. is documented, implemented and maintained,
f. is communicated to all persons working for or on behalf of the organization, and is available to the public.

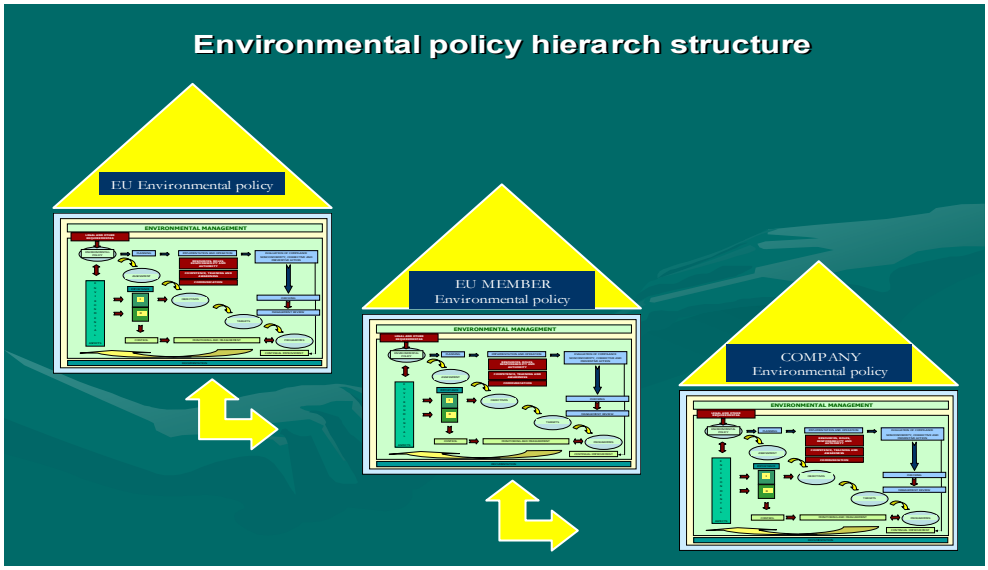

Fig. 2. Environmental policy hierarch structure

13. Modeling of recycling and environmental waste management in constructions

Taking action on waste is essential, since we are consuming natural resources at an unsustainable rate and contributing unnecessarily to climate change. Each year we generate about 100 million tonnes of waste from households, commerce and industry combined. Most of this currently ends up in landfill, where biodegradable waste generates methane, a powerful greenhouse gas. And much valuable energy is used up in making new products which are later disposed of, so also contributing to climate change (www.defra.gov, 2008).
The Government's *Waste Strategy for England 2007* identifies the good potential to increase resource efficiency in construction and reduce waste. The construction industry is a major source of waste in England, using the highest tonnage of solid material resources in any sector, over 400 million tonnes. The construction, demolition & excavation (CD&E) sector generates more waste in England than any other sector, and is the largest generator of hazardous waste, around 1.7 million tonnes. By comparison, the sector accounts for 9–10% of GDP. Objectives of the waste strategy for the construction sector include:

- provide the drivers for the sector to improve its economic efficiency by creating less waste from design to demolition
- treat waste as a resource, re-using and recycling more and asking contractors for greater use of recovered material
- improve the economics of the re-use and recycling sector by increasing demand and securing investment in the treatment of waste (www.defra.gov, 2008) .

13.1 Strategies for recycling building materials

From these statements arise the role and the importance of Environmental Management and Waste Management as waste being one of the by-products of constructions. There needs to be a change in the Waste Management approach philosophy – from managing to economizing waste (Kralj, 2005). This approach means a change in the philosophy of the management of a company, which proves that environmental policy is a part of business policy. So the elements of Environmental Management are included in all elements of business processes, activities and products of this company as in planning, producing and the life cycle of individual products. Top management shall ensure that the environmental policy:

a. is appropriate to the purpose of the organization,
b. includes a commitment to comply with requirements and continually improve the effectiveness of the environmental management system,
c. provides a framework for establishing and reviewing environmental objectives,
d. is communicated and understood within the organization, and
e. is reviewed for continuing suitability (IWA 1:2005 (E) ,2005).

The organization's strategic planning and the policy provide a framework for setting of objectives. With management review only control the activities which leading to improvement of the organization's performance. The objectives should be capable of being measured in order to facilitate an effective and efficient review by management. When establishing these objectives, management should also consider:

- current and future needs of the organization and the markets served,
- relevant findings from management reviews,
- current product and process performance,
- levels of satisfaction of interested parties,
- self-assessment results,
- benchmarking, competitor analysis, opportunities for improvement, and
- resources needed to meet the objectives (IWA 1:2005 (E) ,2005).

For this purpose there are various tools and regulations in the organizational and technical-technological field and in the field of controlling human resources and the treatment in line with employee's abilities. The consequences of this (tools and regulations) are economy effects which develop into Sustainable Development effects (Kralj, 2004). Especially in the case of environmental protection and Environmental Management it is important that we are very cooperative, creative and aim-oriented (Kralj, Krope, Goricanec, 2005).

Recycling and reuse of materials have long been associated with wise construction practices. Experienced contractors are now reaping the economic advantages of Construction Waste Management. Communities are also seeing the side benefits as listed below.

13.2 Research of recycling of waste

Europe is entering a new energy landscape. Our import dependency is 50% today, and certain to rise. Our hydrocarbon reserves are running down. Energy is becoming more expensive. Our infrastructure needs improving; EUR 1000 billion is needed over the next 20 years to meet expected energy demand and replace ageing infrastructure. And global warming has already made the world 0.6°C hotter. These challenges are common to all of Europe. They require a European response. At the end of 2005, European Heads of State and Government reunited at Hampton Court (United Kingdom) call for a true European Energy

Policy (ec.europa.eu, 2007). In Europe buildings use between 5 to 15 per cent energy in so crucial contribute to greenhouse emissions (ec.europa.eu, 2007. Study of heat protection and efficient use of energy in buildings brings new recognition in area of planning, performance and using of objects in their life cycle. It has theoretical and practical meaning. Efficient use of energy in buildings affects a lot of factors, including but not limited to sustainable development aspect in planning, environmental management aspect in business construction processes, care for natural resources and their efficient use, achieving technical specifications of construction products and reducing construction waste with method of sustainable production and raw materials. Use of recycling construction materials in civil construction and efficient use of energy in buildings present one of the very important method for efficient sustainable use of materials and energy. Up until now, issues of modeling and improvement of heat protection and efficient use of energy in buildings have not been adequately addressed as it is required by sustainable development approach. Ecological concerns provided the need for intensive research of recycling of waste. Why is such kind of study important? Because of environmental protection:

- by minimizing waste,
- saving of fossil fuels due to recycling,
- to improving recycling process,
- optimized use of available resources,
- improved intellectual capital,
- optimized, effective and efficient processes,
- enhanced organizational performance, credibility and sustainability
- reduced costs.

The care for reputation, that the enterprise profit with the environment protection and permanent development, places the reprocessing and recycling to the base of the organizational goals (oikos.com, 2007). The process of recycling begin by product design and development. Some of these benefits may include: lower costs, stimulation of innovation, new business opportunities, and improved product quality (Kralj, 2006). Because of stimulation of innovation, new business opportunities and lower costs, the process of recycling into product design and development is so important. Figure presents construction waste material: concrete from lightweight aggregates, which is typical construction waste. In our case we studied the possibilities for the recycling. If you look at the recycling facts, you will see that since 1990, the United States has improved dramatically in their recycling activities. Recycling facts report that fifteen years ago, the U.S. recycled roughly fifteen percent of our waste materials, which today has doubled to thirty percent! The following recycling facts are both interesting and fun bits of information to increase your knowledge on the art of recycling (Rue, L.W., Byars, L.L, 1992). There are many uses for the recycled material in products that we use every day. Some of the more common ones are paper towels, aluminum, and newspaper. The reason are increasingly better technical possibilities for waste processing which reduce the burden on the environment and are very economic. Another reason refers to the use of natural sources. An additional stimulation for searching new possibilities of waste disposal is the waste disposal levy. If we want to change the proportion between waste being disposed and waste being processed in favour of the later, there will be a lot of challenges for us in the future (www.arso.gov.si, 2006). In constructions waste disposal represents one of the main issues of Environmental Management and has an important influence on the environment, especially hazardous

waste. Waste Management includes the collection, movement, processing, and disposal of waste, and also the monitoring of these activities.

13.3 Waste management review

Review shall include assessing opportunities for improvement and the need for changes to the environmental management system, including the environmental policy and environmental objectives (ISO 1401:2004). Records from management reviews shall be maintained. Inputs to evaluate efficiency as well as effectiveness of the environmental management system should consider the customer and other interested parties and should include:

- status and results of environmental objectives and improvement activities,
- status of management review actions items,
- results of audits and self-assessment of the organization,
- feedback on the satisfaction of interested parties, perhaps even to the point of their participation,
- market-related factors such as technology, research and development, and competitor performance,
- results from benchmarking activities,
- performance of suppliers,
- new opportunities fro improvement,
- control of process and product nonconformities,
- marketplace evaluation and strategies,
- status of strategic partnership activities,
- financial effects for environmental related activities, and
- other factors which may impact the organization, such as financial, social or safety conditions, and relevant statutory and regulatory changes.

By extending management review beyond verification of the environmental management system, the outputs of management review can be used by top management as inputs to improvement processes (ISO 1401:2004). Selected output should be communicated to demonstrate to the people in the organization how the management review process leads to new objectives that will benefit the organization. Figure 3 presents an approach to environmental management - waste management.

13.4 Life-cycle assessment (LCA)

Life-cycle assessment (LCA) is a process of evaluating the effects that a product has on the environment over the entire period of its life thereby increasing resource-use efficiency and decreasing liabilities. It can be used to study the environmental impact of either a product or the function the product is designed to perform. LCA is commonly referred to as a "cradle-to-grave" analysis. As LCA is a continuous process, companies can begin an LCA at any point in the product/function cycle. LCA can be used for the development of business strategy purchasing decisions, for product and process design and improvement, for setting eco-labeling criteria and to communicate about environmental aspects of products (images.google.si, .2008) . Key elements are:

- Identifies and quantifies the environmental loads involved; e.g. the energy and raw materials consumed, the emissions and wastes generated;
- Evaluates the potential environmental impacts of these loads;
- Assesses the options available for reducing these environmental impacts.

Life Cycle Analysis is essentially a method of considering the entire environmental impact, energy and resource usage of a material or product. It is often known as a 'cradle-to-grave' analysis and can encompass the entire lifetime from extraction to end-of-life disposal. Life cycle analysis can be an extremely effective way of linking many different aspects of the environmental impacts of materials usage. The scope of a life cycle analysis can be adjusted to suit a particular case (images.google.si, 2008). Figure 5 schematically shows how the disparate areas under the heading of 'environmental materials' can be linked via a life cycle analysis approach.

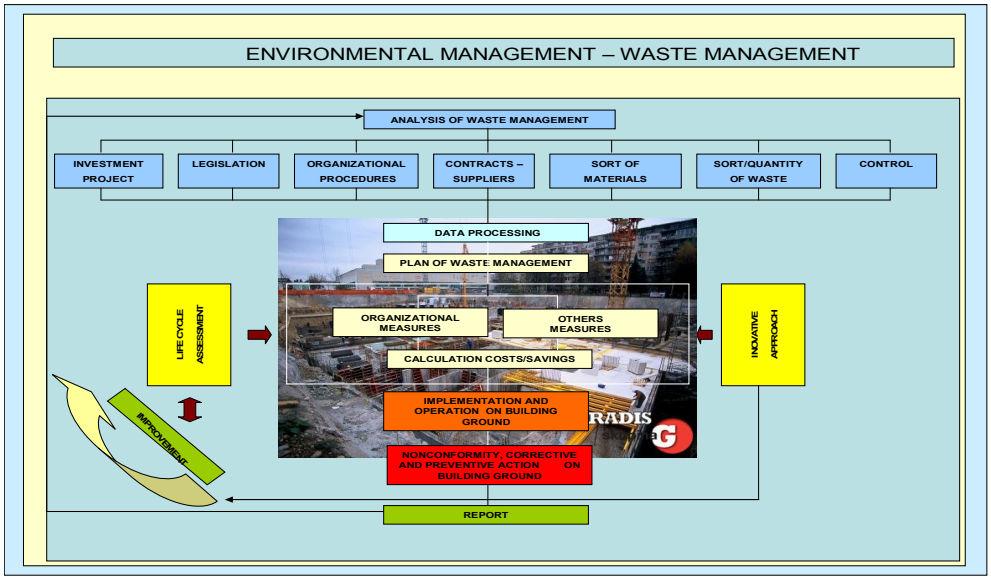

Fig. 3. Environmental management – waste management

13.5 Environmental management and environmental indicators

Managing quality to achieve excellence means managing an organization, business or unit so that every job, every process, is carried out right, first time, every time. To be successful this must be viewed as a holistic approach that affects, and involves, everyone – employees, customers, suppliers, shareholders and society. It must be driven from within the organization, as it cannot be imposed from outside and is not a simply a cost-cutting or productivity improvement exercise. The EFQM Excellence Model was introduced at the beginning of 1992 as the framework for assessing organizations for the European Quality Award. It is now the most widely used organizational framework in Europe and it has become the basis for the majority of national and regional Quality Awards. The EFQM Excellence Model is a practical tool that can be used in a number of different ways:

- As a tool for Self-Assessment
- As a way to Benchmark with other organizations
- As a guide to identify areas for Improvement
- As the basis for a common Vocabulary and a way of thinking
- As a Structure for the organization's management system (www.efqm.org , 2008)

The Model, which recognizes there are many approaches to achieving sustainable excellence in all aspects of performance, is based on the premise that:
Excellent results with respect to Performance, Customers, People and Society are achieved through Leadership driving Policy and Strategy, that is delivered through People, Partnerships and Resources, and Processes.
One of the most widely used voluntary environmental initiatives is the ISO 14001environmental management standard. ISO 14001 is an international environmental management standard that offers a systematic approach to compliance and continual improvement while being flexible and widely applicable to a variety of organizations, such as manufacturers, service providers, and government agencies (Kralj, 2007).
ISO 14001 was developed by the International Organization for Standardization to provide a template for environmental management systems. In order for facilities to obtain ISO certification they must:

- Develop a policy statement on the organization's commitment to the environment.
- Identify the environmental impacts of products, activities and services.
- Make a commitment to compliance with applicable laws and regulations.
- Set environmental goals for the organization, anddeveloping the means to achieve them
- Establish roles and environmental responsibilities within the organization.
- Maintain documents about the EMS and relatedprocedures.
- Monitor key activities and track EMS performance to correct problems and prevent reoccurrences.
- Audit the EMS to verify that it is effective and achieving objectives and targets to ensure that it is still suitable and appropriate.
- Make a commitment to continual improvement of the EMS (ISO 14062:2002(E), 2002).

An EMS is the organizational structure and associated responsibilities and procedures to integrate environmental considerations and objectives into the ongoing management decision-making processes and operations of an organization. According to an EPA summary, an EMS is a continual cycle of planning, implementing, reviewing and improving the processes and actions that an organization undertakes to meet its business and environmental goals. Most EMSs are built on the "Plan, Do, Check, Act" model. This model leads to continual improvement based upon:

- Planning, including identifying environmental aspects and establishing goals [plan];
- Implementing, including training and operational controls [do];
- Checking, including monitoring and corrective action [check]; and
- Reviewing, including progress reviews and acting to make needed changes to the EMS (Kralj, 2007).

Environmental indicators are powerful tools that serve many purposes, useful as tools for performance evaluation and public information. Together with its member countries, the OECD has established a common approach and framework for developing, measuring and using environmental indicators: the OECD Core Set and its core environmental indicators (CEI); several sets of sectoral environmental indicators (SEI) (e.g. transport, energy); a small set of key environmental indicators (KEI) (www.oecd.org, 2008). Environmental indicators are among the most applicable tools used for the purposes of environmental reporting. Based upon numerical data demonstrating the status, specific characteristic or development of a certain phenomenon, they can warn of specific issues. They help us measure and determine the quantity of diverse data constituting a complete data collection. The indicators are, in fact, data that have been collected and presented in an agreed manner,

with the purpose of establishing the connection between the existent data and the targets of the environmental policy.
Reporting of environmental data is measured by and as the level of completeness of environmental data reported in compliance with the requirements stipulated by the European Environment Agency (EEA). This level is presented in an assessment established by the EEA in its annual Progress Report – Priority Data Flows in EIONET, hereinafter referred to as PDF, addressed to the Management Board of the EEA. Picture 1presents Reporting of environmental data – level of completeness of environmental data collected in compliance with the requirements stipulated by the European Environment Agency (EEA) (Kralj, 2008).

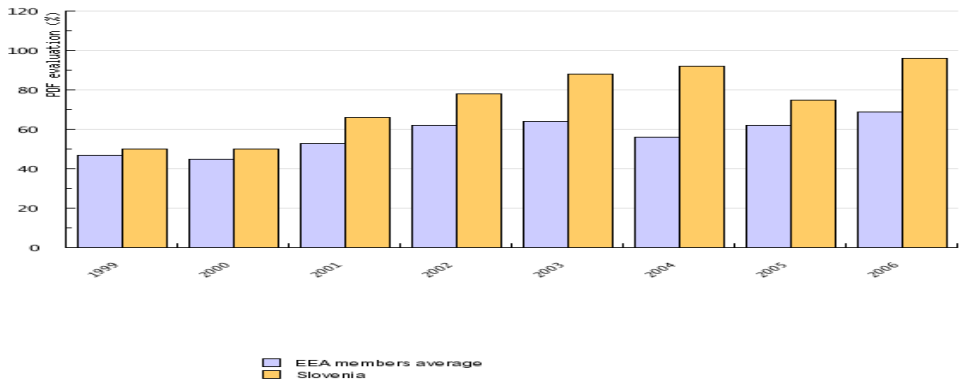

Fig. 4. Reporting of environmental data. Source: Progress Report – Priority Data Flows in EIONET, European Environment Agency, 2007.

The obligation to report to the European Environment Agency by the Republic of Slovenia arises from Article 8 of the Agreement between the European Community and the Republic of Slovenia concerning the Participation of the Republic of Slovenia in the European Environment Agency and the European Environment Information and Observation Network, signed and ratified by the Slovenian Parliament (OJ RS – MP No 18/01) which determines that the Republic of Slovenia should provide data according to the obligations and practices established in the Agency's work. So far, we have communicated to the EEA reports on the state of water, air quality and air emissions, protected areas, state of soil, implementation of the CORINE Land Cover project, etc. The preparation and communication of reports is implemented through the EIONET Network in Slovenia. The compliance of Slovenia's reporting with the requirements defined by the EEA has been subject to assessment since 2000. In this period Slovenia has, as the majority of other EEA Member States, in particular new EU member states, shown significant progress. Decline of average evaluation value in 2004 was caused by inclusion of new reports in PDF, stricter criteria and accession (or collaboration) of new countries to EEA. Pursuant to the PDF criteria, Slovenian reports have achieved 96% conformity with the EEA's reporting requirements, placing Slovenia in 3th place among 37 assessed countries.

13.5.1 Methodology

The research topic is a comprehensive business organization process inside an enterprise in a modern, competitive economy, with particular emphasis on environmental management

and the implication of ISO 14000 Standards. The research aims at establishing the significance of environmental management in an enterprise's own perception, in the perception of a customer and in the perception of a wider social community. It also aims at establishing the kind of environmental indicators in enterprises which show the state in the area of environmental features or environmental management development, respectively. An example of application was based on a random sample of 120 Slovenian enterprises (http//www. gzs.si/register. Enterprise Register (23.12.2006), those that are registered for integrated environmental permit according to IPPC (Integrated Polution Prevention and Control) directive, as well as the holders of the SIST EN ISO 14001: 2005 Certificate and those operating in line with EMAS (Eco-Management and Audit Scheme) regulations. The results include questionnaire replies from 120 received questionnaires.

3.1 Research purpose

The purpose of this paper is to study and define the most important indicators influencing environmental management effectiveness and efficiency in enterprises, focusing on Slovenian enterprises. The focus is on environmental indicators as the result of environmental management, environmental policy and a strategic direction towards achieving environmental goals as well as constant and continuous training and awareness-raising in stakeholders, employees, customers, suppliers and wider social community.

13.5.2 Research objectives

The research objective was to set or determine and prove the role and significance of environmental management indicators in an enterprise's operations. The reflection included interdisciplinary thinking which enables us to understand and manage the process of environmental management in terms of sustainable development. Based on the assumption that an enterprise respects and complies with environmental legislation, it was analitically examined what types of environmental indicators and measures contribute to a constant and continuous improvement in terms of sustainable development.

In the research the following assumptions were tested:

- assessing the environmental care (protection) in enterprises is practiced on a declarative level (rather than being actually practiced);
- enterprises holding a certificate of environmental management are superior in environmental indicators and effectiveness to those that do not hold such a certificate.

13.5.3 Research method

The research was designed as a qualitative case study as defined by Sharan (1998). It was conducted in the period of 2007 and 2008.

13.5.3.1 Sample

The basic information on the sample unit (theorganization studied) and the respondent (the person who completed the questionnaire), was acquired on the basis of the responses from the first (8 questions) and second cluster or set of questions (the first 5 questions). First of all, the answers that describe the main characteristics of the sample (Figure 2 to 9) are presented. The research included 120 enterprises performing various activities. Among them, the highest number goes to limited liability companies (36.5 %), joint-stock companies (28.7 %) or and institutes (14.8 %), while the lowest number goes to sole proprietors,

unlimited liability companies, or and investment companies, and companies of other legal form (altogether 14.8 %). More than half of enterprises (51.8 %) are involved in servicing activities while 30 % are involved in manufacturing. Other enterprises are either predominantly servicing or predominantly manufacturing. The sample's structure considering the years of operation is as follows: 40.9 % are in operation for more than 30 years, 21.6 % between 16 and 30 years and 37.5 % up to 15 years. The research includes mainly large enterprises. 33 % of the studied enterprises employ above 250 people , 37.2 % from 51 to 250 people, 14.2 % from 11 to 50, and 15% up to 10 people. In our research all the listed enterprises are included.
25 % of the enterprises created the added value of up to 25,000 € per employee, 50 % from 25,001 to 50,000 €, and 25 % above 50.000 €. 40 % of the enterprises created above 1,000,000 € of net profit in 2006, 28.2 % from 100,001 to 1,000,000, and 31 % up to 100,000 €. 41.3 % of the enterprises have established an environmental management system in compliance with ISO 14001:2004 Standard, 34.9 % of the enterprises have established such a system in compliance with the legislation in force in the Republic of Slovenia, 3.7 % of the enterprises have established other systems. One fifth of the enterprises stated that they had no environmental management system established. Among the enterprises holding an environmental certificate, 65.2 % held the ISO 14001:2004 Certificate, 6.1 % held an environmental sign, 4.5 % held an environmental permit and 24.2 % held other certificates (data for the year 2007).

13.5.3.2 Research limitations

A qualitative case study was conducted to acquire information and consiquently research results from the completed questionnaires. However, only part of the research results is presented in this paper. The findings that emerge from the research results cannot be generalized to all forms or types of environmental management.

13.5.4 Research results

13.5.4.1 General information

Only part of analyses' results are presented here. The analyses were conducted with the aim of finding the most suitable environmental indicators and indicating devices in differents areas in an organization. The focus of this paper are two areas:

- leadership and
- processes.

By way of factor analysis, the most suitable indicators were selected. Based on the indicators, the indicating devices were set. They represent the average values on the selected indicators.

13.5.4.2 Leadership

In the continuation, an example of leadership and a set of questions concerning the leadership characteristics in an organization - measured on a scale from 1 (I do not agree at all) to 5 (I agree entirely) - are presented. The focus is on two aspects of leadership: a general view on management of an enterprise and leadership jn terms of environmental management, presuming that these two aspects are interrelated. By way of factor analysis using the Principal Axis Factoring method, followed by Varimax Rotation, the most suitable indicators to assess the above mentionened dimensions aspects of leadership (3 for a general view on management of an enterprise and 5 for environmental management) were selected among 23 indicators:

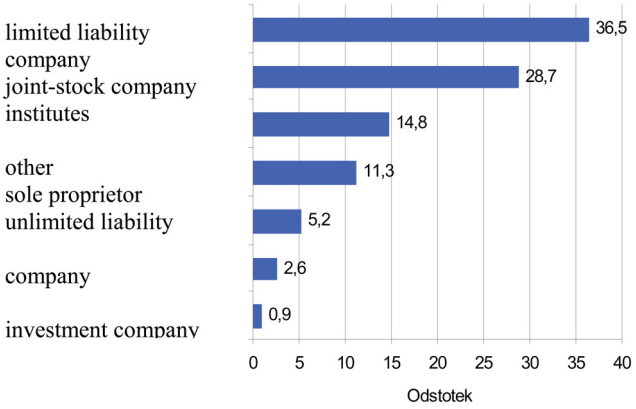

Fig. 5. Enterprise's format

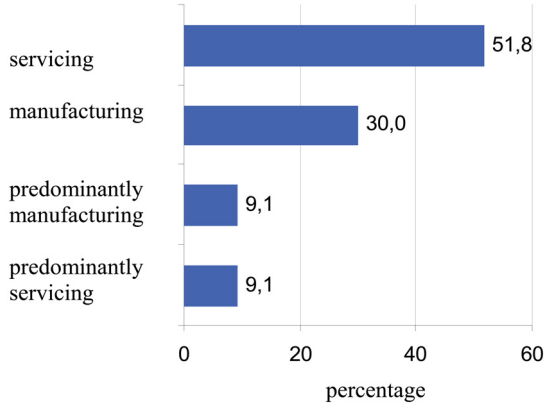

Fig. 6. Enterprise's activity

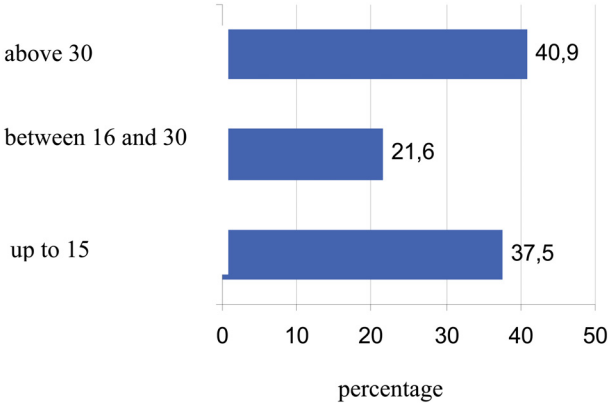

Fig. 7. Years of operation

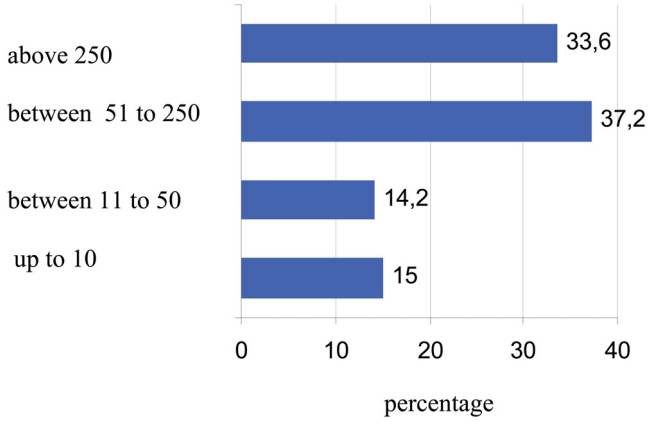

Fig. 8. Number of employees

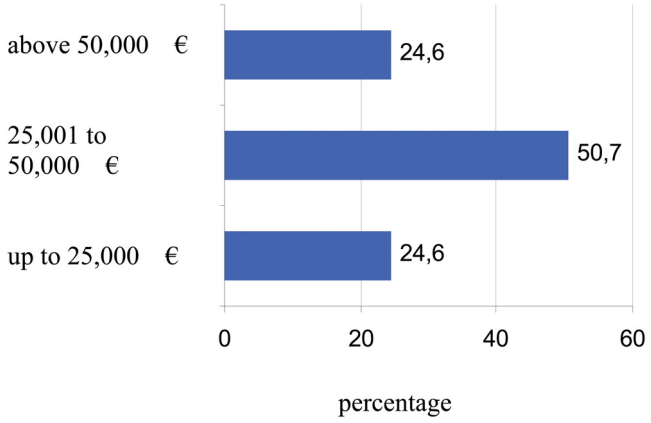

Fig. 9. Enterprise's activity

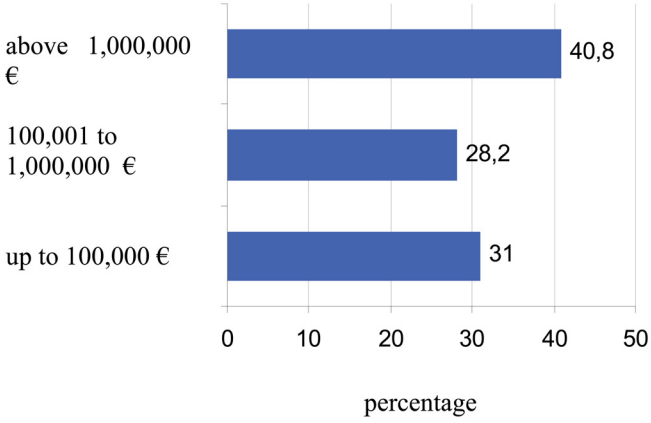

Fig. 10. Enterprise's activity

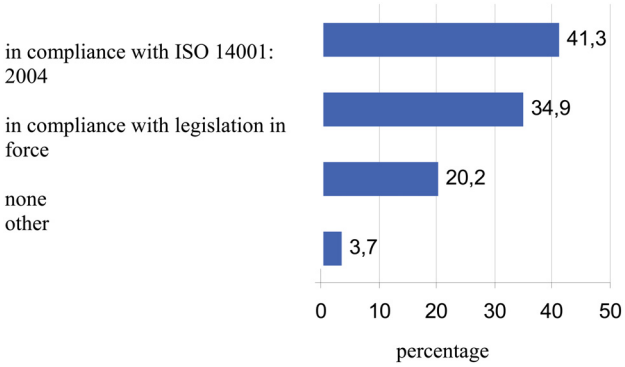

Fig. 11. Enterprise's activity

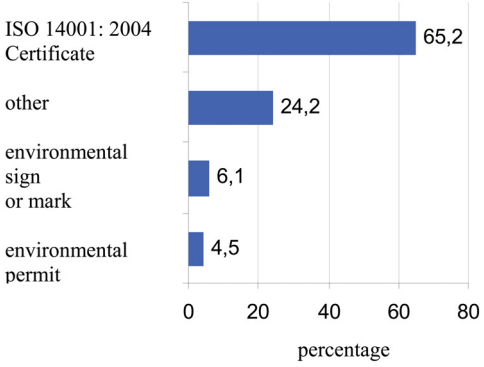

Fig. 12. Enterprise's activity

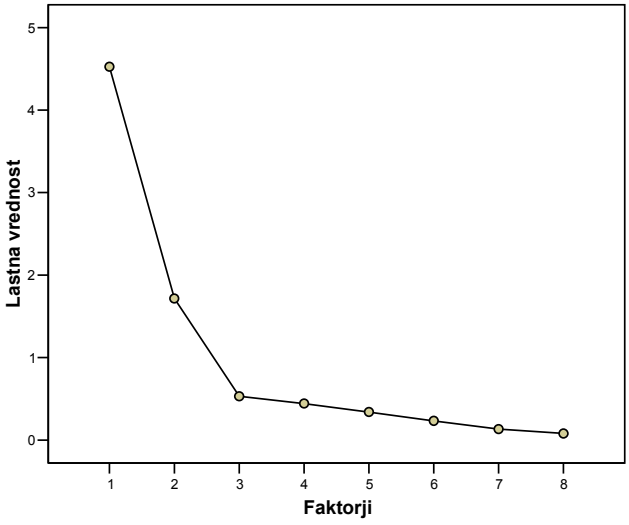

Fig. 13. Graph presenting proper values – leadership

The graph proves that 8 variables can be combined into 2 factors.Using these 2 factors, 72.1 %(after Varimax rotation 53.0 % with the first factor and 19.1 % with the second factor) of the whole variable variance can be explained.
In Table 2 factor loadings after an orthogonal VARIMAX rotation are presented. The factor structure is clear as each indicator has high factor loadings only with one factor. The highest indicators of *leadership quality indicating device in terms of environmental management* are:

- clear vision, strategy and goals;
- careful planning, executing and enhancing measures;
- efficiency and effectiveness assessment;
- promoting initiative and searching new opportunities and solutions for tackling environmental problems
- providing information about environmental issues.

The dimension is most prominently marked by the indicator *Environmental management measures are planned, executed, controlled and enhanced incessantly*, in which the highest factor loading is obtained. The Cronbach reliability coefficient (alpha) value, which measures the reliability of a measuring instrument, is 0.9, suggesting the appropriateness of the choice of indicators.
The indicator *Leadership quality in general* was determined by the followingindicating devices:

- encouraging and promoting autonomy at work;
- encouraging and promoting employee co-operation in decision making and
- identifying the needs for organizational changes

The indicator *Leaders encourage and enable their employees to co-operate in decision making* has a lower factor loading and thus a lower contribution to this dimension. The Cronbach coefficient value is 0.9, therefore, the indicators serve as a reliable measuring instrument for assesing leadership in general.

	Leadership in the area of environmentl management	**Leadership in general**
Environmental management measures are planned, executed, controlled and enhanced incessantly.	0.86	0.14
Leaders assess the efficiency and effectiveness of environmental management business processes.	0.85	0.16
Leaders encourage launching initiatives, searching new opportunities and solutions for tackling environmental problems.	0.80	0.21
Leaders efficiently inform their employees about environmental issues.	0.78	0.25
The management has a clear vision, strategy and objectives concerning environmental mangement.	0.70	0.20
Leaders encourage and promote autonomy at work.	0.19	0.95
Leaders identify the needs for organizational changes and are first to opt for changes.	0.13	0.94
Leaders encourage and enable their employees to co-operate in decision making.	0.33	0.67

Table 2. Leadership – factor loadings after an orthogonal rotation

On the basis of the reliability coefficients, the selected indicators can be used for computing indicators, namely the average value of each indicator, pertaining to a certain dimension as shown in Table 3.

The enterprises statistically significantly assessed *leadership in general* with a higher average grade (3.8) in comparisson to *Leadership in terms of environmental management* (3.3). The value of t-test (Paired Sample t-test) is 5.28 not exceeding a 99 % confidence level. The value of the Pearson correlation coefficient is 0.4 ($p<0.01$), which shows a moderately strong positive correlation between the dimensions. The enterprises that positively or favourably assessed *Leadership in general,* normally positively assessed *Leadership in terms of environmental management.*

	N	Min	Max	Arithmetic mean	Standard deviation
Environmental management measures are planned, executed, controlled and enhanced incessantly.	110	1	5	3.35	1.21
Leaders assess the efficiency and effectiveness of environmental management business processes.	110	1	5	3.16	1.12
Leaders encourage launching initiatives, searching new opportunities and solutions for tackling environmental problems.	110	1	5	3.22	1.14
Leaders efficiently inform their employees about environmental issues.	110	1	5	3.18	1.11
The management has a clear vision, strategy and objectives concerning environmental mangement.	112	1	5	3.71	1.13
Leadership in the area of environmental management	113	1	5	3.33	0.98
Leaders encourage and promote autonomy at work.	101	1	5	3.89	0.88
Leaders identify the needs for organizational changes and are first to opt for changes.	110	1	5	3.91	0.86
Leaders encourage and enable their employees to co-operate in decision making.	111	1	7	3.65	1.01
Leadership in general	111	1	5	3.81	0.83

Table 3. Descriptive statistics of leadership indicators and dimensions

13.5.4.3 Processes

Organizations plan, implement and control processes with a view of meeting their customers' and other participants' expectations and requirements as well as generating greater value for them. Managing functioning of an environmental management system is part of business processes in an organization which is concerned with sustainable development. We were interested in the processes related to environmental management, which were tested by way of the following indicators:

	Percentage
There is no Environmental Management Department.	75.4
Environmental Management Department is inside another department/function.	14.0
There is an independent Environmental Management Department.	10.5
Total	100

Table 4. Is there a special department dealing with environmental management in your enterprise?

Three quarters of enterprises do not have a special Environmental Management Department, 14 % of them have such a department inside another department/function, 10.5 % of them have an independent Environmental Management Department, as shown in Table 4. The obtained data show the leadership's attitude towards the organization of Environmental Management Department. In some enterprises, environmental management is an outsourced service.

A clearer picture of the situation and entity in charge of the analysis of business processes and environmental management (whether an enterprise has an Environmental Management Department or not) is shown in Table 5. One fourth of the enterprises were not willing to/did not know how to answer the question - who is in charge of such an analysis; most of them belong to the group which does not have a special Environmental Management Department. Interestingly, among the enterprises that have a special department dealing with environmental management, the analysis of business processes and environmental management is undertaken by the same department only in 35.7 % of the enterprises. In one third of the enterprises that do not have such a department the analysis is undertaken by the executives. It is a fact that the familiarity with the processes from the environmental management perspective does not depend only on the Environmental Management Department but also on the accountability and competence as well as working methods in a particular enterprise. The analyses of processes are undertaken by those in charge of particular processes; an ecologist may be a member of such a team.

		Is there an Environmental Management Department in your enterprise?		Total
		yes	no	
Who is in charge of the analysis of business processes and environmental management in your enterprise?	No answer.	7.1%	31.4%	25.4%
	Nobody.		12.8%	9.6%
	Executives.	25.0%	33.7%	31.6%
	Other departments	25.0%	12.8%	15.8%
	Environmental Management Department.	35.7%	2.3%	10.5%
	Other.	7.1%	7.0%	7.0%
Total %		100.0%	100.0%	100.0%
Total N		28	86	114

Table 5. Person in charge of the analysis of business processes and environmental management according to whether the enterprise has a special Environmental Management Department or not

Table 6 shows the frequency of the efficiency of environmental management monitoring. One fifth of the enterprises do not monitor it at all, 27. % of the enterprises monitor it annually, 16.5 % semi-annually, 9.6 % every three months, 19.1 % monthly, and only 7 % weekly or even more often.

	Percentage
Not at all.	20.9
Annually.	27.0
Semi-annually.	16.5
Every three months.	9.6
Monthly.	19.1
At least weekly.	7.0
Total	100

Table 6. How frequently do you monitor the efficiency of environmental management?

Concerning the shares in terms of types of environmental management indicators' monitoring, Table 7 shows that most enterprises identify the indicator of waste and sewage sludge (60 %), half of them waste water, four tenths of them noise, waste energy and traffic as well as waste air, and 27.8 of them soil. Natural resources are monitored by 24.3 % of the enterprises, the nature is monitored by 15.7 % of them, electromagnetic radiation by 9.6 % of them and other indicators by 3.5 % of the enterprises. 27 % of the enterprises monitor none of the environmental management indicators. The scales of all the above presented indicators were transformed to the values from 1 to 5, except in cases when an organization identifies none of the indicators (in such a case, the lowest value equals 0). Next we designed an indicator called »processes«, which represents the average of all the indicators. Due to rather low correlations between the indicators, the measuring instrument is less reliable, the value of Cronbach coefficient namely equals only 0.56.

	%
Waste and sewage sludge.	60.0
Wastewater.	50.4
Noise.	40.9
Energy and traffic.	40.9
Waste air.	40.0
Soil.	27.8
None.	27.0
Natural resources.	24.3
Nature.	15.7
Electomagnetic radiation.	9.6
Other.	3.5

Table 7. How many environmental management indicators do you identify?

Table 8 shows the descriptive statistics of the indicators and dimensions for processes. The value of the indicator 'processes' is below the average value, which shows that environmental management processes have mainly not been introduced or yet put in place in the enterprises studied.

	N	Min	Max	Arithmetic mean	Standard deviation
Is there an EM Department in your enterprise?	114	1	5	1.7	1.3
How frequently do you monitor the efficiency of environmental management?	115	1	5	2.5	1.2
How many environmental management indicators do you identify?	115	0	4.5	1.6	1.4
Processes	115	0.5	4.8	1.9	1.0

Table 8. Processes – descriptive statistics of indicators and dimensions

The frequency of environmental management monitoring depends on the type of activity and consequently the type of environmental impacts, geographical location of an enterprise, requirements of the relevant environmental legislation and the size of an enterprise. Time schedule alone, without identifying the previously listed facts, does not yield a realistic result. The type and consequently the number of indicators both depend on the type of activity, therefore, the indicators for production activities, as a rule, substantially differ from those for service activities. A simplified implementation of the number of indicators distorts the actual management of environmental impacts functioning of processes. Therefore, a further study of environmental management is indispensable. .

The average value of the indicator *Leadership in terms of environmental managemen*t is statistically significant, at a confidence level not exceeding 99 %, which is higher than the average value of the indicator *Processes in the area of environmental management*.

From the research results, we can conclude that:

At a declarative level, environmental care is reflected in leadership and policy, strategy and organizational culture in the area of environmental management, whereas the actual care is implemented in the processes related to this area. By using pair t-test we can check if the average value of the indicator *Processes in the area of environmental management* is statistically significantly lower than the average value of indicator *Leadership in terms of environmental management* , as shown in Table 9.

In the area of environmental management we suggest the following short-term and long-term measures with a view of improving operations in the studied enterprises:

- Management should incorporate environmental management in an enterprise's operations as part of current practices.
- It is necessary to establish or determine the most suitable and optimal size of particular environmental indicators and indicating devices (environmental management indicating devices) in terms of an enterprise's activity and size.

		Arithmetic mean	N	Standard deviation	t	p
Pair 1	Leadership in the area of environmental management	3.33	113	0.98	15.498	0
	Processes	1.92	113	0.96		

Table 9. Descriptive statistics of the indicators

- Time schedule for monitoring environmental indicators and indicating devices (environmental management indicating devices) needs to be adapted to an enterprise's operations and size as well as to its environmental impacts, considering environmental legislation.
- It is necessary to incessantly develop suitable environmental values, knowledge and skills with all employees concerning their functions.

14. Conclusion

The content and methods of administration and leading have an essential meaning for dynamic adaptation of business systems in relation to marketing economy. From the cognition, that the innovation brings better exploitation of all potentials, also on the domain of environment protection, it results the measurement of responsible people with the administration of business systems. The whole treat of environment in the administration and leading of professional processes is inevitable condition for the preservation of natural balance in the environment. Punctual creativeness and direction are results of relationship managers have to the environment. In the words of Elkington "sustainability is the principle of ensuring that our actions today do not limit the rabge of economic, social, and environmental options open to future generations (Elkington, 1997). Companies also face judgement in the court of public opinion, where they can found guilty of selling or using products, processes, or practices that have a negative impact on the climate (Lash and Wellington, 2007). The potential benefits associated with an effective EMS include:

- assuring customers of commitment to demonstrable environmental management;
- maintaining good public/community relations;
- satisfying investor criteria and improving access to capital;
- obtaining insurance at reasonable cost;
- enhancing image and market share;
- meeting vendor certification criteria;
- improving cost control;
- reducing incidents that result in liability;
- demonstrating reasonable care;
- conserving input materials and energy;
- facilitating the attainment of permits and authorizations;

- fostering development and sharing environmental solutions;
- improving industry-government relations (ISO 14004:1996(E), 1996)

The whole treat of environment in the administration and leading of professional processes is inevitable condition for the preservation of natural balance in the environment. And finally, in the business processes innovation model, there is the knowledge of business processes managers to be used to implement business process innovation policy in the following steps: vision, mission, strategy, tactics, and management processes.

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3

Enhancing the Ecosystem Services in Viticulture Farms: Approaches towards a Sustainable Management

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1. Introduction

At the start of the twenty-first century, the problem of global sustainability is widely recognised by world leaders. The idea of sustainability dates back more than 20 years, the term was coined in the 1987 by the Brundtland Commission that defined, accordingly to the most often-quoted definition, the sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations General Assembly, 1987).
Sustainable development is a tool adopted by world policy-makers to integrate environmental, economic and social issues to contribute to a more balanced development and to prevent problems linked to the environment and the society. This important concept has been drawn in a variety of ways, commonly as interlocking circles (Figure 1).

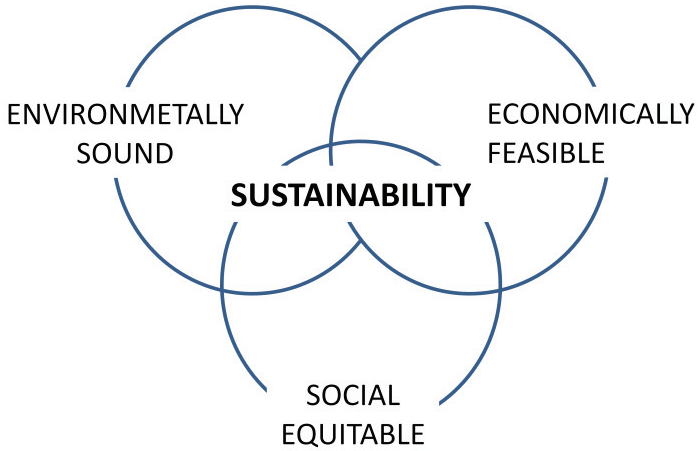

Fig. 1. Graphical definition of Sustainability

The translation of these important concepts in the agriculture, led the American Society of Agronomy in 1989 (FACTA, 1990) to define "Sustainable Agriculture" as an integrated

system of plant and animal production practices having a site-specific application that will over the long-term:

1. Satisfy human food and fiber needs.
2. Enhance environmental quality and the natural resource base upon which the agriculture economy depends.
3. Make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.
4. Sustain the economic viability of farm operations.
5. Enhance the quality of life for farmers and society as a whole."

In the EU Common Agricultural Policy (CAP), environmental considerations have increasingly been integrated into agricultural policy throughout Europe. Multifunctionality of agriculture (production of environmental, socio-cultural and economic services other than food production) is becoming a key issue in the reforms. "Sustainability" (European Commission, 1998), "sustainable development" and so "sustainable agriculture" are terms that tend to be found very often in the new European Directives, and indicate the general direction of the communitarians policies of this new century.

The present study reports a way to evaluate the environmental impact of viticulture and the use of case study methodology to document how this managing tool has been used in an Italian winegrowing farm. In fact, viticulture represents one of the cultivations most impacting the ecosystem due to its distribution and geographical concentration.

The development and operation of a vineyard can impact on the environment in many ways (table 1). Undesirable impacts can be caused by practices which result in a physical change to the environment caused by activities/practices which cause disturbances to the environment; and substances or organisms being placed or moved to a location where they do not belong. Winegrowing practices can have immediate and long-term negative effects on the environment and may also affect the productivity of the vineyard. The environmental contaminants are substances or organisms that are placed or moved to an unintended location, soils; ground water; surface water; atmosphere; and plants and animals, within the environment are referred to as environmental contaminants. These include: nutrients and their by-products; pesticides and their by-products; salt; sediments; metals; oils; exotic/introduced pests, diseases, weeds; and general waste. The environmental impacts are caused as a direct result of vineyard activities/practices; and as a result of contaminants moving into unintended locations. These have influence on soils; water; air; flora, fauna and ecosystems; natural resources; and regional aesthetics and amenity. It should be noted that the environment is a highly complex system and many factors interact. As a result, impacts on one aspect of the environment can cause follow-on impacts on other aspects of the environment.

The eco-sustainable recovery of viticulture is subordinated to the possibility of management at the farm and basin level, through an integrated assessment that allows to evaluate the risks produced by each productive factor within all the life cycle of the vineyard (Cliff O., 2000).

In Italy the "Università Cattolica del Sacro Cuore" in collaboration with experts on evaluation and management of environmental risks, and on data treatments, have developed SOStain a proactive and voluntary program of Environmental Sustainability. The aim of SOStain program is to increase the Sustainability of Italian winegrowing farms, through a whole of practical recommendations for the vineyard and winery management that can be used by conventional and organic farms. These recommendations are resumed

Threatening process related to viticulture	Main influencing factors	Corresponding Mitigations (Example of sustainable practices)
Loss of ecological processes	Ecosystem fragmentation. Distribution of breeding and regeneration cycles. Imbalances in species populations. Biodiversity loss	Maintain Ecosystem integrity Sustain Biodiversity
Diminished air quality/climate change	Increasing of particulate matter and ozone in the atmosphere Global warming resulting from GHGs (CO_2 and NO_2)	Air quality protection Reduction of emission
Land and water salinisation	The use of water for irrigation	Water conservation & efficiency Maintenance and setup of irrigation system
Water pollution	Pollution from irrigation drainage water, soil erosion, the use of fertilizers and pesticides, and from in channel sediments. Land clearing and agricultural development.	Protection of aquatic ecosystems and aquifers Improvement of discharge water quality
Soil erosion, problems with structure and/or quality of soil	Lack of soil surface cover. Low winter rainfall. Soil compaction Loss of nutrients	Soil conservation & management Monitoring of soil status
Outbreaks of pests	Improper use of pesticides Lack of pest management plan	Integrated pest management Pest, mites, weed, vertebrate monitoring
Changing land use	New vineyard developments	Environmental constraints on vineyard establishment

Table 1. The main threatening factor related to viticulture

in the SOStain Code of Sustainable Practices. The SOStain Code of Sustainable Practice promotes winegrowing and winemaking practices that are compatible with the environment, responsive to the needs and interests of society-at-large, and are economically feasible in practice. It include a self-assessment check-list to assess the sustainability of current practices and to identify areas of excellence and areas where improvements can be made. The assessment and the interpretation of results occurs trough the use of agro-environmental indicators that are significant components of data collection systems. The

indicators help decision-makers by informing them of the linkages and tradeoffs between farm activities and environmental impacts. They can provide an early indication of potential changes in the state of the environment. Because of that the agro environmental indicators plainly have a valuable role to play in progressing sustainable development objectives.
In this work we propose the use of an informatic tool able to assess the environmental performance of vineyard management in a whole, that can be used by single winegrowers at farm level. The software is based on EIOVI, environmental impact of organic viticulture indicator, an indicator developed for the evaluation of the environmental sustainability in the context of organic viticulture (Fragoulis et al., 2009). This paper intends to demonstrate the application of EIOVI to conventional viticulture, and to illustrate the important fast diagnosis of the winegrowing systems and their insertion in the territories that EIOVI permits.

1.2 Agro-environmental Indicators

The agricultural practices vary from the fertilization to the protection of the culture with plant protective products, from the irrigation to the soil cultivation. Effort should be given in developing risk assessment methodologies for the entire environmental compartment using the best science available and including an harmonized procedure for ecotoxicological criteria that combines the principles of European policies.
The Commission of the European Communities (2000) defines "agro-environmental indicators" as a generic term designating a range of indicators aiming at giving synthesized information on complex interactions between agriculture and environment. The EC has provided two key documents on this topic: COM(2000) 20 (European Commission, 2000) provides a partial set of 35 indicators for assessing environmental integration; COM(2001) 144 (European Commission, 2001) used this partial set to identify what statistics are required to underpin the indicators (Enrisk, 2003).
In support of the implementation of the integration objectives of agro-environmental policies, indicators are required to assess progress made and to evaluate the achievement of agronomic and environmental objectives, in order to optimize the systems.

1.3 EIOVI

EIOVI (Environmental Impact of Organic Viticulture Indicator) is an environmental indicator, reliable to EU organic farm management that could help as a decision support system for farmers and other property managers in choosing among options and evaluating the impact of their choices. The indicator aims to measure all the actual environmental impact produced by agro-ecosystem in the spatial boundaries of the farm and to produce advice for improving the sustainability of the human actions.
The indicator is implemented in a, user friendly, software with a graphical user interface (GUI) that allows the user with minimum input data to obtain an overall estimation of the impact of the management of his vineyard on the environment. To describe the relationships between the various management options and the environmental impact, a fuzzy expert system has been adopted.
This important tool could be used also to evaluate the environmental performance of conventional viticulture, with a series of correcting factors that consider the use of non organic fertilizers, and the addition of a range of sub-indicators related to the use of conventional pesticides, as indicated in this paper.

2. Materials and methods

2.1 The fuzzy expert systems

The theory of fuzzy is used to describe relationships that are best characterized by compliance to a collection of attributes (Zadeh, 1965). In classical set theory, an element either belongs or does not belong in a set, this means that the membership function can only take two values: 0 (non-membership) and 1 (membership). The fuzzy set theory addresses this type of problem allowing one to define the degree of membership of an element in a set by means of membership functions that can take any value from the interval [0.0, 1.0]. The value 0.0 represents complete non-membership; the value 1.0 represents complete membership and the values in between represent partial membership. Therefore, for the development of this environmental indicator, for each agronomical practice it has been formulated a set of decision rules attributing values between 0 and 1 to an output variable according to the membership of its input variables to the fuzzy subsets F (favorable) and U (unfavorable). To compute the modules, Sugeno's inference method (Sugeno, 1985) has been used. At the same time, the limit values beyond which the index is certainly F or U must be given. With this procedure, three membership classes are created; F, U, and partial (or fuzzy) membership (Werf & Zimmer, 1998).

These limit values are based on criteria drawn from the literature or on expert judgment. In this software S shaped membership functions are used because they provide smoother variations of the input values than functions that are linear in the transition interval. The hierarchical structure of this technique is used to aggregate indices into first level fuzzy indicators and next, into a second level fuzzy indicator for the whole system. The aggregation process is achieved by combining weighted fuzzy values. In figures 2 is given a graphical presentation of a classical crisp set (A) and a fuzzy set (B) (Bellocchi et al., 2002).

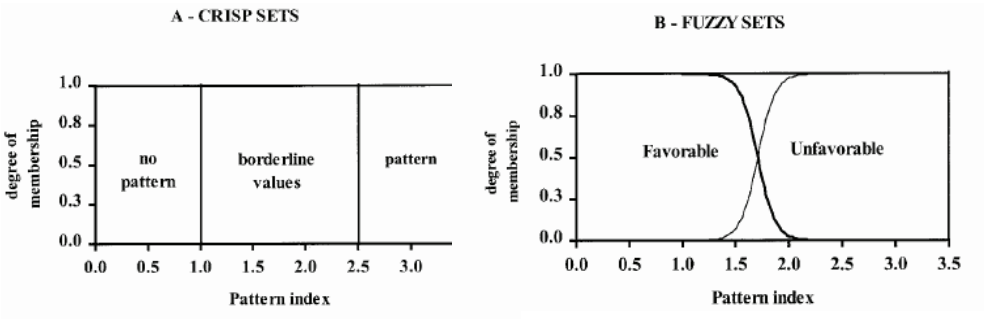

Fig. 2. Graphical presentation of crisp (A) and fuzzy sets (B) for the pattern index

2.2 Modules

The assessment tool is organized into six modules related to the main agronomic practices having an important environmental impact and on soil organic carbon and flora and fauna biodiversity impact. The modules are: (i) pest and disease management, (ii) soil management and machinery use, (ii) fertilizer use management, (iii) irrigation management, (iv) soil organic carbon, and (v) biodiversity of flora and (vi) fauna. The modules are activated one by one. Specific functions are then selected that apply the indicator for assessing the relevant environmental protection end-point.

Only modules relevant to specific geographic conditions are activated, and the flexible framework allows implementation of new ones when available. A number of agro-ecosystem functions takes place within each module.

2.2.1 Pest and disease management

The pest and disease management indicator (PDMI) is based on the EPRIP indicator (Padovani et al., 2004) and uses the concept of "Exposure Toxicity Ratio" (ETR). A ETR is the ratio between a "Predicted Environmental Concentration" (PEC) and a toxicological end point (i.e., legal limit groundwater, LD50, NOEL). This ratio is calculated for each of the environmental compartments at risk: ground water, surface water and soil. Toxicological effects on humans and ecotoxicological effects on aquatic and soil organism are taken into account. The user can select a plant protection product, application type, and application rate and can see the potential environmental impact depending on the soil properties of the farm and the hydrogeologic and meteorologic properties of the area.

2.2.1.1 Exposure to Toxicity Ratio for Soil

The PEC_{soil} is calculated as detailed in the final report of the Soil Modelling Work Group of FOCUS (FOCUS, 1997) and is the same approach as applied in the EPRIP indicator (Padovani et al., 2004). PEC_{soil} is a function of substance properties (DT50), application scheme (application rate, number of applications, and interval between applications), and soil properties (bulk density). For the soil PEC soil compartment, the ETR is

$$ETR_{soil} = PEC_{soil}/LC50 \text{ (earthworms)} \quad (1)$$

PEC_{soil} and LC50 are in mg kg^{-1}.

2.2.1.2 Exposure to Toxicity Ratio for Ground Water

The method of calculation of PEC_{gw} is based on the approach used in the EPRIP indicator using the leaching quantity index (Rao et al., 1985). The leaching quantity index is derived from the attenuation factor and is a function of substance properties (Koc, DT50, and Kh), application rate, crop stage at the time of application, soil properties (sand and clay content, bulk density, and organic carbon content), hydrogeological properties (depth of ground water table and ground water level), and meteorological properties (average annual precipitation). For ground water, the ETR is

$$ETR_{gw} = PEC_{gw}/LegalLimitGroundwater \quad (2)$$

PEC_{gw} and LegalLimitGroundwater are in µg L^{-1}.

2.2.1.3 Exposure to Toxicity Ratio for Surface Water

The PEC_{sw} comprises PEC_{sw} due to drift and PEC_{sw} due to runoff . The mean percent drift loading is estimated as in the FOCUS Drift Calculator (FOCUS, 2001) and is a function of the distance from the edge of the treated field to the closest and farthest edge of water body, application rate, number of applications, and water body depth. Due to run-off , PEC_{sw} is calculated using the same empirical approach as in the EPRIP indicator and is a function of substance properties (Koc, DT50), application scheme (application rate, number of applications, and interval between applications), crop stage at the time of application, distance from the water body, soil properties (bulk density and organic carbon content),

hydrogeological properties (slope and quantity of water lost by runoff), and meteorological properties (maximum daily rainfall). For surface water, the ETR is

$$ETR_{sw} = [\max(PEC_{drift}, PEC_{runoff})]/[\min(EC50_{Daphnia}, LC50_{fish}, EC50_{algae})] \quad (3)$$

PEC_{drift} and PEC_{runoff} are in mg L^{-1}.

2.2.1.4 From Exposure to Toxicity Ratio to a Fuzzy Expert System

If x is the value of the index, α is the lower limit, and γ is the upper limit of the index, the S-shaped membership function used for the PMI is flat at a value of 0 and 1 for $x \leq \alpha$ and for $x \geq \gamma$, respectively. Between α and γ, the S function is a quadratic function of x (Bellocchi et al., 2002):

$$S(x,\alpha,\gamma)\begin{cases} 0.0 & x \leq \alpha \\ 2x\left(\frac{x-\alpha}{\gamma-\alpha}\right)^2 & \alpha \leq x \leq \beta \\ 1-2x\left(\frac{x-\gamma}{\gamma-\alpha}\right)^2 & \beta \leq x \leq \gamma \\ 1.0 & x \geq \gamma \end{cases} \quad (4)$$

where $\beta = (\alpha + \gamma)/2$, $S(x, \alpha, \gamma) = 0.0$ means complete membership to F, and $S(x, \alpha, \gamma) = 1.0$ means complete membership to U.
The parameters x, α, and γ for the indicators of soil, ground water, and surface water that constitute the overall PDMI are given in Table 1.

	SW indicators	GWindicators	SWindicators
x	ETR* soil	ETRgw	ETR sw
α	0.1	0.1	0.001
γ	1	1	0.01

*ETRgw, exposure toxicity ratio for ground water, ETRsoil exposure to toxicity ratio for soil; ETRsw, exposure to toxicity ratio for surface water

Table 2. Parameters x, α, γ for the soil water (SW), ground water (GW), and surface water (SW) indicators.

To assess the overall PDMI, a set of decision rules has been formulated for each module, attributing values of between 0 and 1 to an output variable according to the membership of its input variables to the fuzzy subsets F and U and according to Sugeno's inference method (Sugeno, 1985). When the premises are linked by a conclusion, the truth value of a decision rule is defined as the product of the truth values of its premises. The decision rules describing the effect of different indicators in the overall PDMI are given in Table 2. The score is calculated as the sum of the conclusions of the decision rules, weighted by the sum of their truth values.

2.2.2 Fertilizer management indicator

The use of compost as a management tool is highly relevant for the grape growing industry. Although the use of compost in viticulture can result in a wide range of benefits, there is

GW indicator	SW indicator	Soil indicator	PDMI
F	F	F	0.0
U	F	F	0.7
F	U	F	0.7
F	F	U	0.2
F	U	U	0.8
U	F	U	0.8
U	U	F	0.9
U	U	U	1.0

Table 3. Decision rules describing the effect of the different indicators in the pest and disease management indicator (PDMI)

also the risk of potentially detrimental effects (Biala, 2000), such as the oversupply of nutrients and contamination with heavy metals.

In viticulture, the use of temporary or permanent green cover crops in place of crop rotations in permanent cultures of vines and in orchards can bring benefits in addition to the more well known functions of erosion prevention, ground cover, and diminution of ground pressure (Hofmann, 1994), specifically, (i) improvement of soil structure and water conservation by permanent root spreading; (ii) nutrient supply for soil organisms as a basis for high biological activity and availability of soil nutrients; (iii) adaptation of nutrient supply specifically for the growth of grapes through specific mulching management and the use of herbs and nitrogen fixing plants; and (iv) support and stabilization of fauna in the vineyard ecosystem (canopy and green cover) through mowing, cutting, o rolling treatments in alternate rows to enable the blossoming of green manure plants. The use of different kinds of cover crops in viticulture should also be considered.

The fertilizer management indicator (FMI) takes into account the presence, type (legumes, grass or other, and mixture), and yield (kg ha^{-1}) of cover crops, the percentage of the vineyard covered, compost use in the last 4 yr, and the possible use of commercial fertilizer. The FMI is comprised of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) sub-indicators. These three sub-indicators are a function of soil organic matter and bulk density; the C/N ratio of the compost; the N, P_2O_5, and K_2O content; and the rate of compost (or fertilizer) application, taking into account the nutrient demand (N, P_2O_5, K_2O) of an organic vineyard with or without cover crops.

The high levels of nutrients contained in compost have a direct effect on plant growth. The nutrient requirements of grapevines should therefore be taken into account when compost is used. Grapevines have a relatively low demand for nutrients, depending on the yield and variety. For organic vineyards, the nitrogen (N) demand from fertilizer (NDF) is estimated to be between 50 and 80 kg N ha^{-1} (Biala, 2000). The compost or fertilizer N indicator (CMFNI) considers NDF, taking into account of the N release from humus mineralization, the cover crop demand/contribution for/of N, and the total N that becomes available for plant uptake during the first year of compost and/or commercial fertilizer use (NAT). Taking into account the latter and the relatively low demand for nutrients by grapevines only small quantities of N must be supplied by compost amendment.

When a cover crop is present, the N demand of the cover crop must be added to the N demand of the vineyard (Bowman et al., 2007). The maximum N demand of a cover crop, assuming two thirds of the soil to be covered with grass, has been estimated to be 30 kg N ha^{-1}. This figure is corrected on the basis of the actual coverage of the vineyard. However, N-fixing plants such as legumes contribute to N fertility, and this is also taken into account where such plants are used as cover crop. Organic N in compost is not immediately available to crops due to the time required for microbial mineralization of organic matter. The C/N ratio of organic material influences microbial activity. The greater the ratio, the more limiting N becomes for the microbial decomposition of organic matter. When composts with C/N ratios greater than 20:1 are added to soil, mineral N and any subsequently mineralized organic N can become "appropriated" by microbes (immobilized in the microbial biomass), leaving plants N deficient. Thus, the C/N ratio of compost is an important factor in the calculation of plant-available N. Availability coefficients are used to calculate plant-available N and thus to predict mineralization in the field.
As a general rule, 10% of the remaining organic N is available in the next season. Only about 40% of the applied N will be available for plant uptake over time (Biala, 2000).

2.2.2.1 Nitrogen Available for Plant Uptake from Commercial Fertilizer

Some organic farmers also use commercial fertilizers. The N from commercial fertilizer is immediately available to the plant. To calculate CMFNI, the NDF is compared with the total NAT. The S-shaped function of Eq. [4] is used with the parameters x, α, and γ for the indicator CMFNI taking the values x = NAT, α =NDFmin, and $\gamma = 2 \times \text{NDFmax} - \text{NDFmin}$, where NDFmin and NDFmax depend in each case on the presence and type of cover crop and the percentage of the vineyard covered.

2.2.2.2 Compost or Fertilizer Phosphorus Indicator

The compost or fertilizer phosphorus indicator (CMFPI) considers the phosphorus demand from fertilizer (PDF) of a vineyard with or without cover crops. The total plant-available phosphorus (PAT) of a compost and/or mineral fertilizer is based on the fact that approximately 20% of phosphorus in compost reacts like P in mineral fertilizers and is immediately available for plant uptake, whereas the remainder is more strongly bound and becomes available over time (Biala, 2000). Consequently, during the first year, 30 to 40% of the applied P becomes available to plants. The grapevine has a low demand for P (15–25 kg P_2O_5 ha^{-1} yr^{-1}).
Cover crop plants actively compete for nutrients, and it is essential to maintain an adequate supply in the soil for both. This applies especially for P and K. Fertilizer recommendations are based on the maintenance of adequate availability in the soil and the replacement of any nutrients removed. For a soil of moderate nutrient status, the P demand of a grass and legume mixture cover crop has been estimated to be 40 kg ha^{-1}, based on a coverage of 67% of the vineyard. The actual P demand of the cover crop is corrected on the basis of coverage.
For commercial fertilizer, the same approach is followed as for N. The PAT is compared with the PDF, and the S-shaped function of Eq. [4] is used with the parameters x, α, and γ for the indicator CMFPI taking the values x = PAT, α = PDFmin, and $\gamma = 2 \times \text{PDFmax} - \text{PDFmin}$, where PDFmin and PDFmax in each case depend on the presence and the type of cover crop and the percentage of the vineyard covered.

2.2.2.3 Overall Fertilizers Management Indicator

The decision rules describing the effect of the three different sub-indicators of the FMI are indicated in the Table 4.

CMFNI	CMFPI	CMFKI	FMI
F	F	F	0.0
F	U	F	0.7
F	U	U	0.8
F	F	U	0.2
U	F	F	0.7
U	U	F	0.9
U	F	U	0.8
U	U	U	1.0

Table 4. Decision rules describing the effect of the different sub-indicators on the fertilizer management indicator.

2.2.3 Water management indicator

The indicators relevant to water management are (i) the water management quality indicator (WMQI) and (ii) the water management irrigation rate indicator (WMIRI).

2.2.3.1 Water Management Quality Indicator

The WMQI is composed of three sub-indicators. The water management salinity indicator (WMSI) is a function of electrical conductivity (EC; mmhos cm^{-1}) and total dissolved solids (mg L^{-1}) in irrigation water and the irrigation system. The water management infiltration indicator (WMII) is a function of EC and sodium adsorption ratio (mmol L^{-1}) of irrigation water and the irrigation system. The water management ion toxicity indicator (WMITI) is a function of the concentration of sodium (Na; meq L^{-1}), chlorine (Cl; meq L^{-1}), and boron (B; mg L^{-1}) in irrigation water. As for the PDMI, an S-shaped membership function is used that is flat at a value of 0 and 1 for $x \geq \alpha$ and for $x \geq \gamma$, respectively. Between α and γ, the S function is a quadratic function of x (Eq. [4]). The parameters x, α, and γ for the indicators WMITI, WMSI, and WMII that affect the overall WMQI are given in Table 5.

	WMITI			**WMSI**		**WMII**	
x	Na	Cl	B	EC	TDS	EC	SAR
α	3	4	0.5	0.7	300	0.2	10
γ	7	8	1	3	1500	2	26

Table 5. EC, electrical conductivity; SAR, sodium adsorption ratio; TDS, total dissolved solids; WMII, water management infiltration indicator; WMITI, water management ion toxicity indicator; WMSI, water management salinity indicator.

For WMII only, S(EC; α; γ) = 0.0 means complete membership to U, and S(EC; α; γ) = 1 means complete membership to F because a very low EC creates infiltration problems in the soil if the sodium adsorption ratio is high.

A set of eight decision rules describes the effect of the three sub-indicators in the overall WMQI.

2.2.3.2 Water Management Irrigation Rate Indicator.

The vine growing season must first be defined. An irrigation scheduling program should indicate when to irrigate and how much water to apply to achieve specific objectives. Yields

of most crops are directly related to the volume of water consumed. Maximum potential water use is therefore desirable. However, the production of quality wine grapes usually requires the use of an irrigation strategy providing less than the maximum potential water requirement of the vine. Recent research has shown that water deficits can have a significant, positive impact on wine quality (Prichard, 2004). There are at least two approaches for regulated deficit irrigation (RDI): (i) the volume balance approach (VBA) and (ii) the deficit threshold (DTI) plus RDI method. Using the VBA method, 50 to 70% of the maximum potential water use is sufficient for the grapevine. The DTI method relies on a predetermined level of midday water deficit (the threshold) to initiate irrigation. After the threshold is reached, a reduced water regime is used based on a portion of full water use (RDI%). With this method, irrigation begins only if the threshold is reached. If the DTI method is followed, significantly less irrigation water will be used.
The water management irrigation rate indicator uses the reference evapotranspiration (ETo), also known as potential evapotranspiration (PET). Rates of ET_o are adjusted by multiplying ET_o by a crop coefficient (Kc) specific to grapevines, and the full potential water use (ET_c) for a vineyard is estimated. A meteorological database in the software contains monthly average air temperature and rainfall data collected from approximately 30 meteorological stations in Italy, Germany, France, and Switzerland. The monthly ET_o is estimated with the Thornthwaite method (Thornthwaite, 1948), using monthly average air temperature data and latitude (daylight coefficient values for the Thornthwaite formula for different latitudes are presented in the database) for the area of interest. Grapevine Kc are a function of the size of the grape canopy and the proportion exposed to direct sunlight. The equation to describe the relationship between the crop coefficient and the percentage shaded area is (Williams, 2000)

$$Kc = 0.002 + 0.017 \times \text{the percent shaded area} \quad (5)$$

The full potential water use (mm) for the whole growing season is estimated using ETo and Kc. Additionally, rainfall (mm) is estimated for each farm for the same period using monthly average rainfall data taken from the meteorological database. The net irrigation requirement (NIR) for the vineyard is

$$NIR = (Etc - rc \times RAIN + IRCC)/Ic \quad (6)$$

where Ic is the efficiency of the irrigation system used, RAIN is the in-season rainfall (mm), rc is the effective rainfall coefficient, and IRCC is the average in-season irrigation requirements for cover crops (estimated to be 100 × cover crop coverage%/67% for annual cover crops and 200 × cover crop coverage%/67% for perennial cover crops).
To calculate the WMIRI, the irrigation water applied during the growing season (mm) is compared with the net irrigation requirements of the vineyard, and the decision rules presented in Table 6 are formulated. To estimate the effect of the different sub-indicators in the overall water management indicator (WMI), decision rules attributing equal weight to both sub-indicators are applied.

2.2.4 Soil management and machinery use indicator

2.2.4.1 Machinery Use Indicator

The environmental objectives of best practice with respect to machinery use are to avoid and minimize generation of greenhouse gas emissions, damage to native vegetation, generation

Decision rules
If IW† = 0 (no-irrigation) then WMIRI = 0.0
If IW < 0.5 × NIR (DTI irrigation) then WMIRI = 0.1
If 0.5 × NIR < IW < 0.7 × NIR (VBA irrigation) then WMIRI = 0.25
If 0.7 × NIR < IW < 0.85 × NIR then WMIRI = 0.5
If 0.85 × NIR < IW < NIR then WMIRI = 0.7
If IW > NIR then WMIRI = 1.0

DTI, deficit threshold indicator, IW, irrigation water applied during the growing season; NIR, net irrigation requirements; VBA, volume balance approach

Table 6. Decision rules describing the effect of the different parameters on the water management irrigation rate indicator (WMIRI)

of noise, and impact on soil structure. Machinery must therefore be used efficiently and sensibly. The parameters that influence the MUI are machinery power (Kw), hours of machinery use per hectare and per year, machinery age (years), and soil compaction. Again, a fuzzy expert system is used with the S-shaped function of Eq. [4].

2.2.4.2 Machinery Power and Age Indicator

Farmers usually keep records of how many hours they use their machinery in the vineyard. A low-power machine has less negative impact on the environment in terms of greenhouse gas emissions, noise generation, and soil compaction than a high power machine. If the hours of machinery use are multiplied by the machinery power, an indirect estimation of environmental impact can be made. For the machinery power per hours of use indicator (MPI) (Kw h ha^{-1} yr^{-1}), if we consider, as an average of machinery use in a vineyard, a new 38-Kw four-wheel-drive tractor used for 35 h ha^{-1} yr^{-1}, the fuzzy expert system (Eq. [4]) can be used with the following parameters: x = MPI, α = 500, and γ = 1500. However, machinery age can influence environmental impact. New machinery (expressed as power per hours of use) has less negative impact on the environment compared with older machinery of the same power used for the same number of hours per year. A machinery age correction factor (macc) must therefore be introduced in the MPI. The MPI for each machine must be multiplied by the macc to give the machinery power and age indicator (MPAI). The MPAI for the vineyard is

$$MPAI = \Sigma_1^{mn} MPI \times macc \tag{7}$$

where mn is the number of machines used in the vineyard in the reference year.

2.2.4.3 Level of Soil Compaction Indicator

The degree of soil compaction in the vineyard provides an indicator of soil health. Machinery use on wet soil increases soil compaction. For the level of soil compaction indicator (LSCI, MPa), the fuzzy expert system (Eq. [4]) can be used with the following parameters:

x = LSCI, α = 1, and γ = 3.

The estimation of the effects of the different sub-indicators in the overall soil management and machinery use indicator (SMMUI) follows decision rules that attribute equal weight to both sub-indicators (MPAI and LSCI).

2.2.4.4 Alternative for the Machinery Use Indicator

In the event that farmers do not have records of machinery use (hours) and/or are unable to measure soil compaction, the environmental impact of machinery use can be estimated on the basis of the type of machinery (two-wheel-drive, front-wheel-assist, and four-wheel-drive tractors; track tractors, gantry or caterpillar, all-terrain vehicles, fourwheeled motor bike, or animal trained machinery), the type of wheels and tires (radial tires and bias ply tires), and the potential for use on wet soil. If more than one type of machinery is used, the larger score of MTI is used, thus representing a worst case.

2.2.4.5 Cover Crop Indicator

Although some aspects relating to the use of cover crops (impact on irrigation and fertilizer management) have been implemented in other modules (WMI and FMI), the use of cover crops has other benefits for the environment, such as prevention of soil erosion, improvement of soil health, conservation of soil moisture, and reduced need for herbicide use and mineral fertilizer use. The use of cover crops must therefore be seen as a positive soil management practice. The parameters that influence the cover crop indicator (CVCRI) are the cover crop type (annual/legumes, grass or others, mixture or perennial/ rye grass, sod type grasses) and the cover crop use (incorporation into soil as a green manure or left on the soil surface as a mulch). If no cover crop is used (bare soil), then CVCRI = 1.0.

2.2.4.6 Commercial Fertilizer Use Indicator

The use of commercial fertilizer has been implemented in the FMI. Although if done correctly the use of commercial fertilizer may result in no risk according to FMI, the supply of nutrients in this way cannot be sustained in terms of environmental impact compared with nutrient supply through the use of compost. The use of commercial fertilizer must therefore been seen as a negative soil management practice. If commercial fertilizer is used, commercial fertilizer use indicator (CFUI) = U(1.0). If no commercial fertilizer is used, CFUI = F(0.0).

2.2.4.7 Overall Soil Management and Machinery Use Indicator

The decision rules describing the effect of the different parameters on SMMUI are presented in Table 7.

MUI	CVCRI	CFUI	SMMUI
F	F	F	0.0
F	U	F	0.5
F	U	U	0.7
F	F	U	0.2
U	F	F	0.3
U	F	U	0.5
U	U	F	0.8
U	U	U	1.0

CFUI, commercial fertilizer use indicator; CVCRI, cover crop indicator; MUI, machinery use indicator; SMMUI, soil management and machinery use indicator

Table 7. Decision rules describing the effect of the different parameters in the soil management and machinery use indicator

2.2.5 Soil Organic Matter Indicator

The soil organic matter indicator (SOMI) is based on the organic matter indicator (Bockstaller et al., 1997). This indicator evaluates the effect of management practices on the evolution of soil organic matter to maintain soil organic matter at a satisfactory level. The calculation of the indicator is based on the comparison of the organic matter input in compost and cover crop residues with recommended levels of input for an organic vineyard, as given in Eq. [8].

$$SOMI = RAOMI/AAOMI \quad (8)$$

where RAOMI is the recommended annual organic matter input (kg ha^{-1}) for an organic vineyard (Table 7), and AAOMI is the actual annual organic matter input from compost (or manure) and cover crop residues (kg ha^{-1}).

2.2.5.1 Recommended Annual Organic Matter Input

The recommended levels of OM input for vineyards are given in Table 8 as a function of the clay and loam content of the soil. The recommended levels of inputs are expected to maintain a satisfactory level of soil organic matter in the long term. The initial organic matter level in the vineyard must therefore also be considered. Table 8 refers to a soil with an initial organic carbon content of 2 to 3%. The values in Table 7 must therefore be multiplied by an initial soil organic carbon coefficient that depends on the initial organic carbon content of the vineyard.

Loam	**Clay**			
	<20%	20-25%	25-30%	>35%
0-5%	6000	5600	5400	5000
5-15%	5600	5000	4600	4300
> 15%	5000	4300	4150	4000

Table 8. Recommended level of OM input (Kg OM ha^{-1}) for vineyards

2.2.5.2 Annual Organic Matter Input from Compost (or Manure) and Cover Crop Residues

The AAOMI is the sum of the actual annual organic matter input from compost (or manure) use (AAOMIC) and the annual organic matter input from cover crops (AAOMICCR, kg ha^{-1}). The AAOMIC is calculated as

$$AAOMIC = 1000 \times 0.01 \times 1.72 \times CUR \times N \times CNR \quad (9)$$

where N is the nitrogen concentration of compost on a dry matter basis (%), CNR is the C/N ratio of compost, and CUR is the compost use rate (t ha^{-1} yr^{-1}).
The AAOMICCR is calculated as

$$AAOMICCR = 0.01 \times 1.72 \times CCRY \times NCCR \times CNRCCR \quad (10)$$

where CCRY is the cover crop biomass yield (kg ha^{-1}), NCCR is the nitrogen concentration of cover crop (%), and CNRCCR is the C/N ratio of cover crop. For the NCCR, unless better information is available, the following values are used: for legumes %N = 3.5, for grass %N = 2.5, and for mixtures %N = 3.0.

For the CNRCCR, unless better information is available, the following values are used: for legumes CNR = 20, for grass CNR = 40, and for mixtures CNR = 30. For the CCRY, unless better information is available, the following values are used: for legumes CCRY = 2000 × cover crop coverage%/67% kg ha^{-1}, for grass CCRY = 3000 × cover crop coverage%/67% kg ha^{-1}, and for mixtures CCRY = 2500 × cover crop coverage%/67% kg ha^{-1}.

2.2.5.3 Calculation of the Soil Organic Matter Indicator

For the SOMI, a fuzzy expert system is used with the S-shaped function (Eq. [4]). In this case, the parameters x, α, and γ are x = SOMI, α = 0.6, and γ = 1.6.

2.2.6 Biodiversity indicator

2.2.6.1 Biological Diversity

Diversity depends on two main factors, richness and evenness, which are taken into account when calculating the biodiversity indicator (BI). The number of species per sample is a measure of richness. The more species present in a sample, the richer the sample. Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to species that have very few individuals as to those that have many individuals.
Evenness is a measure of the relative abundance of the different species making up the richness of an area. The indicators relevant to biodiversity are the flora biodiversity indicator and the soil fauna biodiversity indicator. For both indicators, the Simpson's diversity index (D) is used (Simpson, 1949).

2.2.6.2 Simpson's Diversity Index

Simpson's diversity index measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). The version of the formula of Simpson's Index for calculating D used in the BI is the following:

$$D = \frac{\Sigma n(n-1)}{N(N-1)} \tag{11}$$

where n = the total number of organisms of a particular species, and N = the total number of organisms of all species.
The value of D ranges from 0 to 1, where 0 represents infinite diversity, and 1 represents no diversity.

2.2.7 Environmental impact of organic viticulture indicator

The indicator of the environmental impact of agronomical practices in organic viticulture (EIOVI) is obtained according to a set of 64 decision rules. These synthesize the indicators of the aforementioned agronomical practices (PDMI, FMI, WMI, and SMMUI) and ecological aspects (SOMI and BI). If one or more of the indicators that form the overall EIOVI cannot be measured due to a lack of data, the EIOVI is calculated using the remaining indicators, and the decision rules are automatically adapted to the number of indicators considered. The indicator was developed for the Organic Viticulture, but with a series of correcting factors that consider the use of non organic fertilizers, and the addition of a range of sub-indicators related to the use of conventional pesticides, EIOVI could be applied also for the conventional Viticulture.

The information that the software requires to consider the environmental impact of synthetic fertilizers are the fertilizer use rate, expressed in kg/ha and the content of Nitrogen (N%); Phosphorus (P%) and Potassium (K%). The environmental impact is calculated as indicated in the previous paragraph.
To introduce an active ingredients between the conventional pesticides used in the pest management plan, a series of information related to the eco-toxycological properties and physical chemical properties are required. The environmental impact is calculated as indicated in the previous paragraph for the organic pesticides applications.

3. Farm testing description and results

The EIOVI indicator was used to calculate the environmental impact and relative ranking for different strategies of treatment with a range of test management scenario, three different vineyards in the same farm. The meteorological conditions are typical for Southern Italy: 350 mm of annual rainfall (RAINFALL), with an average maximum daily rainfall of 45 mm.

3.1 Site 1

In the farm a vineyard of 2 hectare with the a slope of 2% was selected (SITE 1). The soil characteristics were: organic carbon (OC) 0,9%, bulk density (BD) 1.95 g/cm^3, sand content 59%, silt content 18%, and clay content 36%. There was a stream 360 m from the vineyard.
50 % of the total surface was covered with annual cover crops (legumes and grass), which were ploughed in the soil. The total yield of cover crops was around 9000 kg/ha.
The fertilization was carried out using synthetic fertilizer at a rate of 400kg/ha, and N% 7, P_2O_5% 14 and K_2O% 21.
The following active ingredients were used for the crop protection management:

- trifloxystrobin, applied by spraying at a rate of 150 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of flowering (full canopy).
- penconazole, applied by spraying at a rate of 350 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of flowering (full canopy).
- sulfur, powder, applied at a rate of 2500 g/ha, when the vine was in the phenological state of flowering (full canopy).

3.2 Site 2

In the farm a vineyard of 1,5 ha with the slope of 20% was selected (SITE 2). The soil characteristics were: organic carbon (OC) 0,3%, bulk density (BD) 1.13 g/cm^3, sand content 68%, silt content 18%, and clay content 14%. There was a pond at 600m from the vineyard.
50 % of the total surface was covered with annual cover crops (legumes and grass), which were ploughed in the soil. The total yield of cover crops was around 7200 kg/ha.
The fertilization was carried out using compost at a rate of 1 t/ha, and N% 2,5, P_2O_5% 2 and K_2O% 3.
The following active ingredients were used for the crop protection management:

- pyrimethanil applied at a rate of 1000 g/ha, when the vine was in the phenological state of flowering (full canopy).

- trifloxystrobin, applied by spraying at a rate of 100 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of flowering (full canopy).
- penconazole, applied by spraying at a rate of 350 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of fruit-setting.
- sulfur, powder applied at a rate of 2500 g/ha, when the vine was in the phenological state of flowering (full canopy).
- mancozeb, powder applied at a rate of 1000 g/ha, when the vine was in the phenological state of pre-flowering
- deltamethrin, powder applied at a rate of 800 g/ha, when the vine was in the phenological state of flowering (full canopy).

3.3 Site 3

In the farm a vineyard of 3,5 hectares with a slope of 18% was selected (SITE 3). The soil characteristics were: organic carbon (OC) 1,1%, bulk density (BD) 1.62 g/cm^3, sand content 44%, silt content 17%, and clay content 39%. There was a stream at 30m from the vineyard.
50 % of the total surface was covered with annual cover crops (legumes and grass), which were ploughed in the soil. The total yield of cover crops was around 9000 kg/ha.
The fertilization was carried out using synthetic fertilizer at a rate of 400 kg/ha, and N% 7, P% 14 and K% 21.
The following active ingredients were used for the crop protection management:

- trifloxystrobin, applied by spraying at a rate of 150 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of flowering (full canopy).
- penconazole, applied by spraying at a rate of 350 g/ha, in two different application times with an interval of 15 days, when the vine was in the phenological state of fruit-setting.
- sulfur, powder applied at a rate of 2500 g/ha, when the vine was in the phenological state of flowering (full canopy).

In all sites the soil management was carried out using a track tractor (59 Kw) for 35 hours/ha, and a tyre-wheel tractor (67,5 Kw) for 4 hours/ha.
The results of EIOVI simulation (Fig.3; Fig.4; Fig.5) clearly show how the management at the vineyard level could be improved.

4. Discussion and conclusion

SOStain, Sustainable Winegrowing program, is an integral part of the future of Italian wine production. The program aims to constitute a framework for viticultural and winemaking practices that protect the environment while efficiently and economically producing premium winegrapes and wine. The program is clear, solid, flexible and can be implemented through technological innovations and scientific research. The agro-environmental indicators take an essential place in the SOStain program. The use of agro-environmental indicators appears to be indispensable for responsive and cost-effective policies, and to provide harmonized data on environmental progress on Sustainable management. The indicators in this paper provide a basis on which farm manager can have a picture of overall trends that may require action on their part, and as a tool for analyzing the impact of winegrowing and winery activities and policies on the environment. This

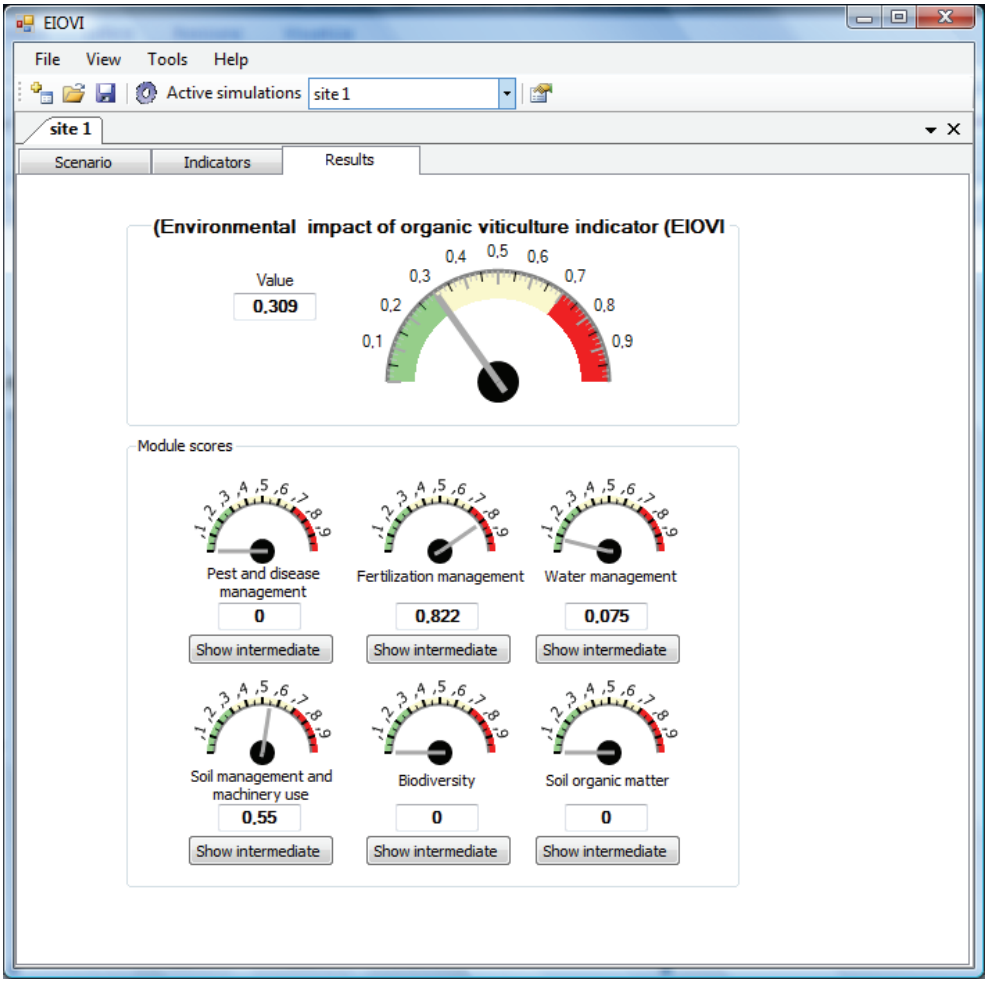

Fig. 3. Environmental impact of organic viticulture indicator (EIOVI) Site 1.

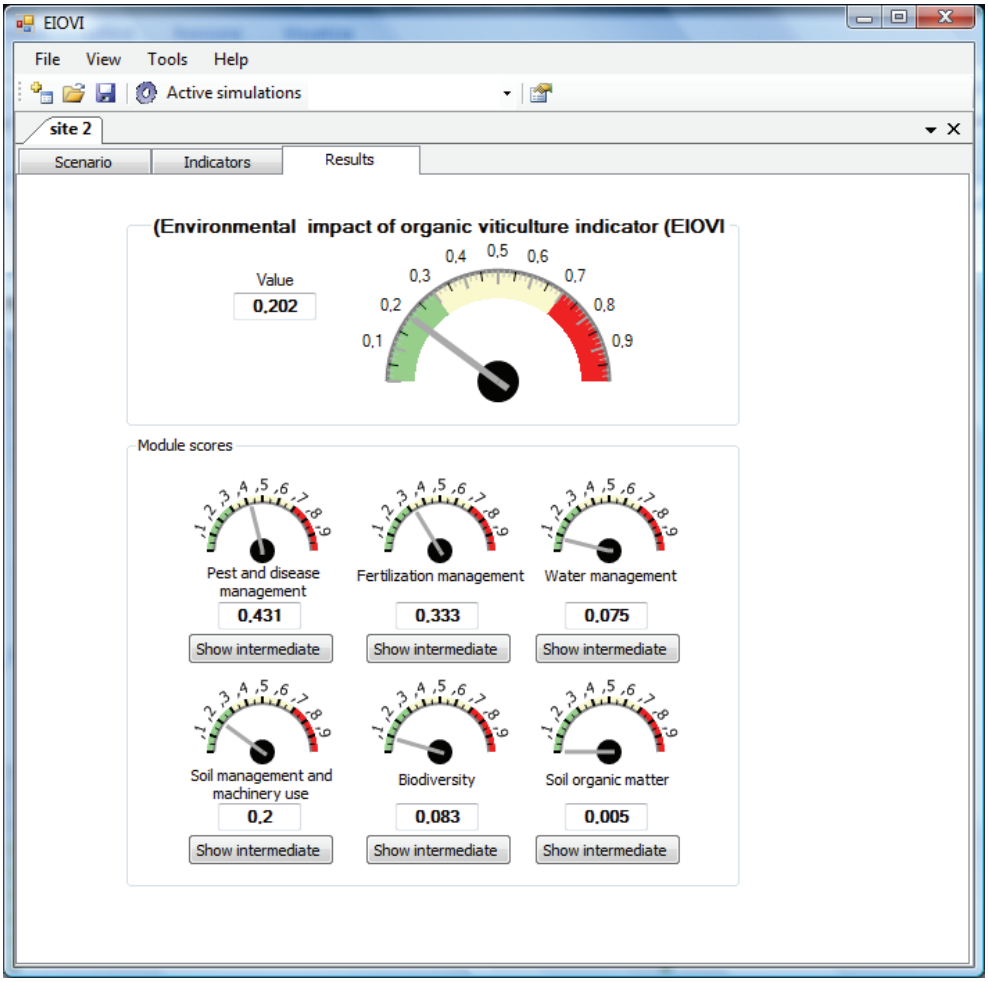

Fig. 4. Environmental impact of organic viticulture indicator (EIOVI) Site 2.

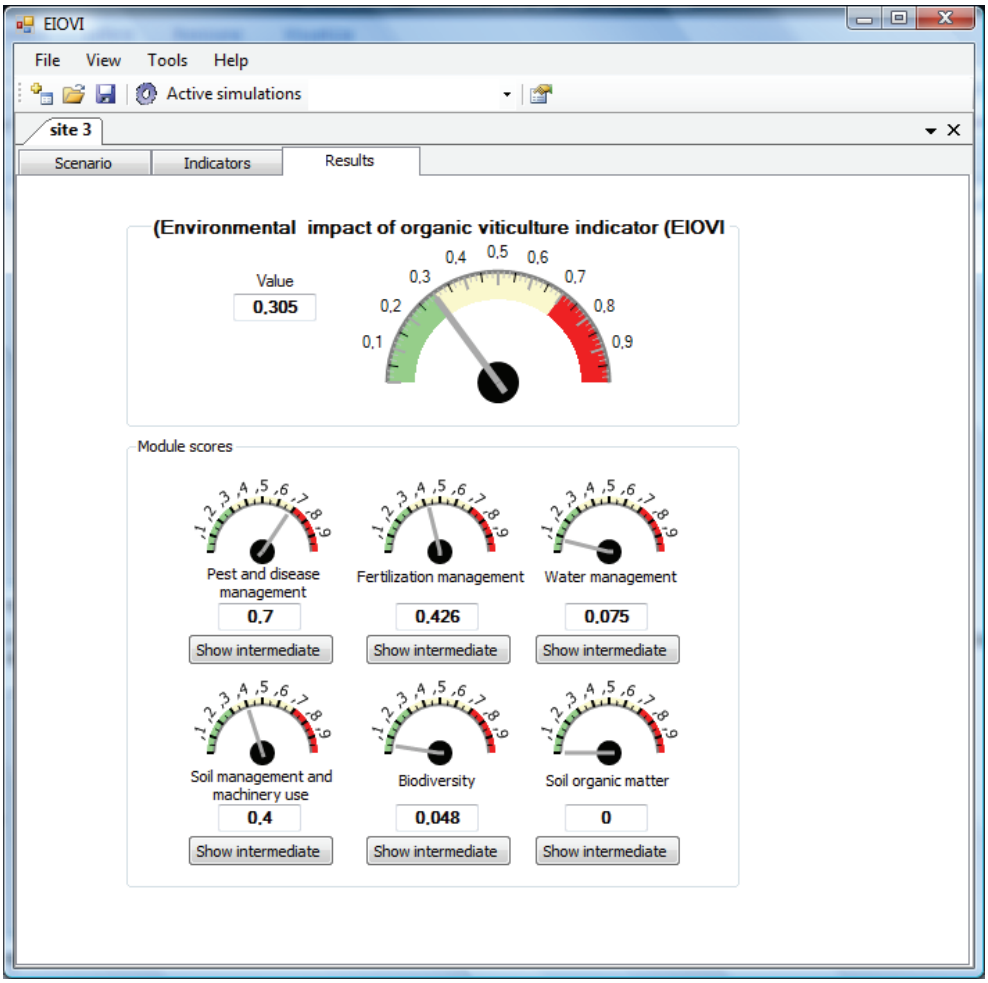

Fig. 5. Environmental impact of organic viticulture indicator (EIOVI) Site 3.

paper presents the use of EIOVI, a fuzzy expert system, that reflects an expert perception of the potential environmental impact of viticulture, in the sustainable farm management. Agro-environmental indicators are necessary to monitor the effectiveness of policies which promote sustainable agriculture. In fact, the objective of an agro-ecological indicator is to render reality intelligible, and the objective of an expert system is the simulation of human actions.The modular organization of EIOVI reflects the complexity of agriculture and can also be used for management planning.

This can be done by applying the indicator, looking at the final score (Figures 3, 4, 5), identifying the management practice (sub-indicator) that affects most the overall score, changing some parameters in that sub-indicator, and going back to the results page to see how the applied changes have affected the indicator's score.

An example is given in Fig. 3, SITE 1. In this case, the FMI has been identified as the sub-indicator having the greatest impact on the overall EIOVI. The application of 400 kg ha^{-1} of a synthetic fertilizer resulted in a FMI score of 0.822, with the intermediate indicators having the values of Fig. 6. Fertilizer nitrogen Indicator (CMFNI) considers the nitrogen demand from fertilization (NDF) of the vineyard taking into account the N release from humus mineralization (NRHM), the cover crop demand/contribution for/of N and the total N that becomes available for the plant uptake during the first year of compost and/or mineral fertilizer use (NAT). On this basis, the application of less fertilizers, and the use of cover crop in soil surface, without incorporation in soil could significantly lowered the FMI (values of intermediate indicators in Fig. 6). In fact particularly nitrogen and phosphorus have the potential of causing detrimental environmental effects if fertilization is used inappropriately. Generally, if large quantities of fertilizers are used (mulching) or if

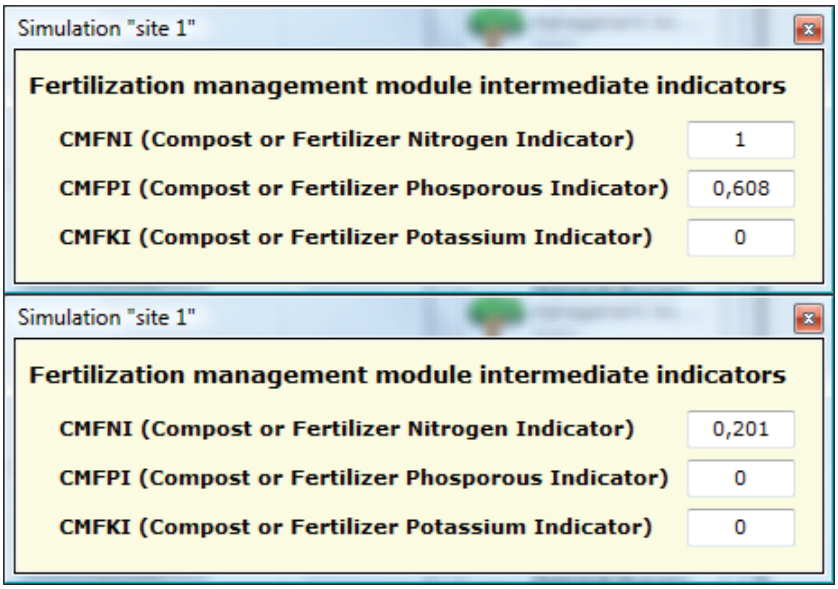

Fig. 6. Intermediate indicators for two management options with different fertilizer use rate, and cover crops use. In the second case the vineyard manager used less fertilizer, and cover crops mulching.

fertilizers is applied to soils where high quantity of cover crops are incorporated, nitrate leaching can occur.
This is a potential problem particularly in viticulture since grapes have relatively little nutrient requirements and many vineyard soils are already very well supplied with phosphorus.
Another example is given in Fig. 4, SITE 2. In this case the PDMI has been identified as the sub-indicator having the greatest impact on the overall EIOVI. The applications of pesticides as indicated in the previous chapter resulted in a PDMI score of 0,431 , with the intermediate indicators having the values of Fig. 7. The high score in the surface water indicator SWI depends on high PEC_{sw}. The PEC_{sw} comprises PEC_{sw} due to drift and PEC_{sw} due to runoff . The drift loading is estimated as in the FOCUS Drift Calculator (FOCUS, 2001) and in this case is high due to short distance of water body, and depends on application rate, number of applications, and water body depth. The application rate reduction, could significantly lowered the SWI and consequentially the PDMI. Moreover a number of mitigation practices could be improved to reduce the pesticides drift in the close water body.
The last example given in Fig. 5, represents the SITE 3. Also in this case the PDMI appears to be the sub-indicators having the greatest impact on the overall EIOVI with the resulting PDMI score of 0,7. The values of the intermediate indicators are reported in the figure 8. The PDMI score is based on PEC_{drift} that is higher than the $PECr_{unoff}$. The reduction in treatment number and in active ingredient quantities employed could reduce the SWI and consequentially also the PDMI.
The EIOVI indicator is the first known tool to evaluate the environmental impact of viticulture. It takes into account the different agronomical practices used in organic viticulture (pest and disease management, fertilizer and irrigation management, soil management, and machinery use) and estimates the effect of vineyard management on soil organic matter and the biodiversity.
Although developed for organic viticulture, it was been extended to conventional viticulture. This was been done by adding new non-organic plant protective products in the active ingredients database of the PDMI. The FMI includes the option to use commercial fertilizer, and the other four sub-indicators can be used for conventional viticulture.
The fuzzy set theory adopted provides an elegant and quantitative solution to determine cut-off values for input variables and for output results. The hierarchical structure of this technique, through the use of decision rules and by combining weighted fuzzy values, allows the aggregation of indices into first-level fuzzy indicators and then into a second-level fuzzy indicator for the whole system. The system has a modular structure and thus provides a synthetic indicator reflecting the overall impact for the whole system as well as detailed information through its six modules.
In conclusion, if some improvements to the tool are implemented, EIOVI will be a helpful assessment tool for vine growers, consultants, environmental agencies, and scientists. EIOVI indicator can drive sustainable pest management practices, and increases the awareness on environmental topics, underlining the critical aspects in the current farm management.
New modules can be added and the flexibility of the system permits the tuning related to expert perception. Therefore, and despite the fact that the theory behind the indicator is quite exhaustive, the tool is provided with a graphical user interface (GUI) that is easy to use (even by the winemakers) and requires only basic input data that are not too expensive or too difficult to be obtained by the users. The tool could be extended to other branches of agricultural production by including perennial cultures, vegetable crops, crop rotation, or livestock husbandry.

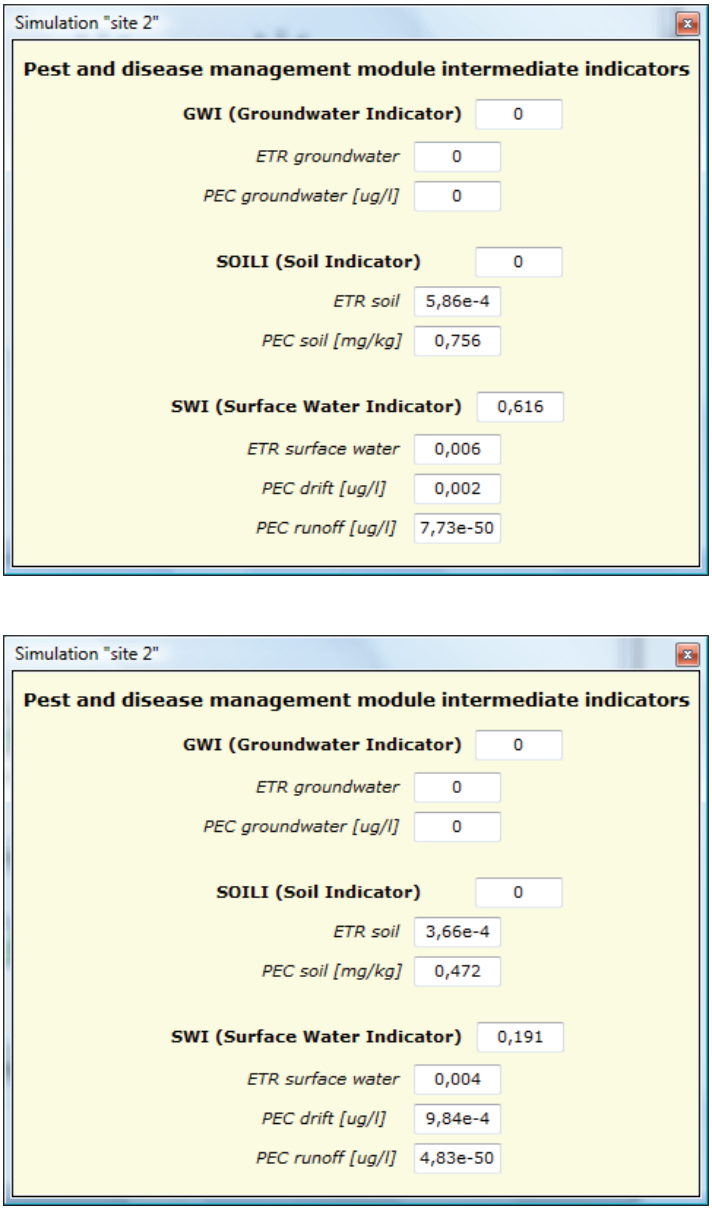

Fig. 7. Intermediate indicators for two management options with different pesticides use rate. In the second case the vineyard manager reduced the treatment rates.

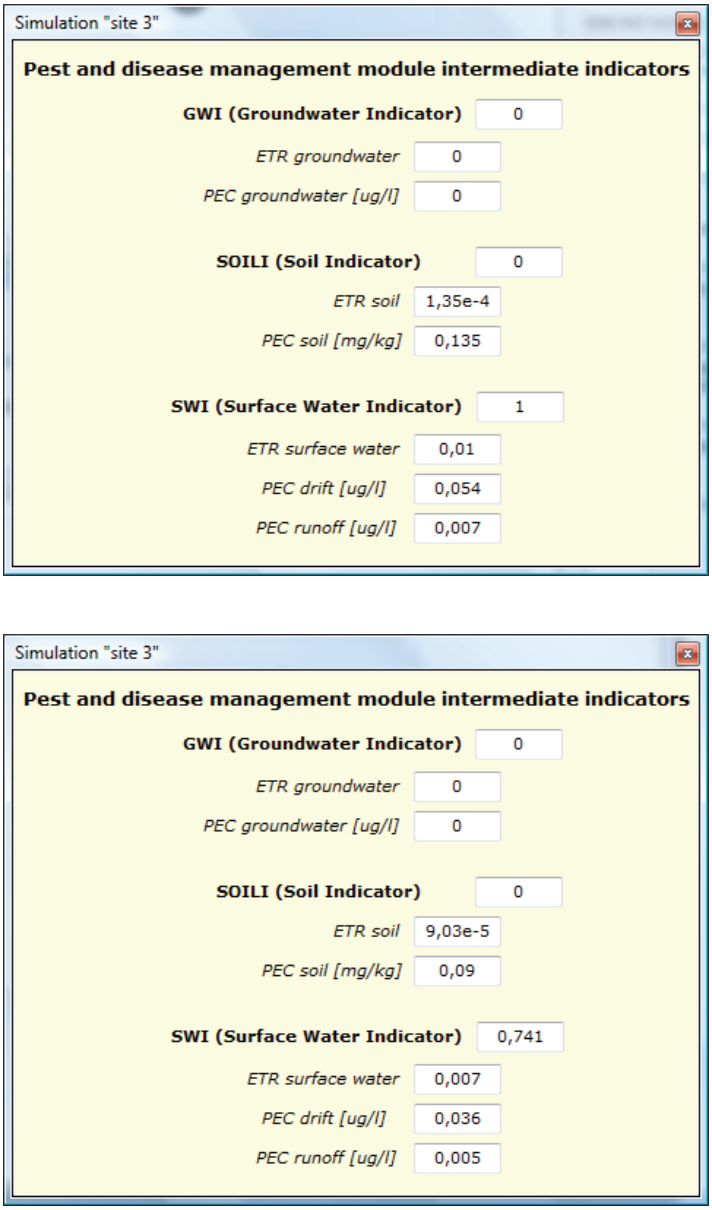

Fig. 8. Intermediate indicators for two management options at different pesticides use rate. In the second case the vineyard manager reduced the treatment rates.

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4

Implementation of Strategic Environmental Assessment in Serbia with Special Reference to the Regional Plan of Waste Management

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1. Introduction

In Serbia, Strategic Environmental Assessment was introduced in 2004 under the Law on Strategic Environmental Assessment ("Official Gazette of the Republic of Serbia 135/04). Previous experience in the application of this instrument is not recorded as well as the appropriate theoretical background so the introduction of SEA in Serbia was without adequate practical and scientific support. Although the Law on SEA is in line with the basic methodological and procedural framework of the Directive 2001/42/EC of the European Parliament and the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive), that was recognized as the only potential taking into account the implementation while as the difficulties were distinguish non-harmonized legal requirements, time period for adjustment, lack of the necessary guidelines and the expertise (Crnčević, 2005). Therefore, it was expressed concern about the possibility of improvisation in the implementation of the provisions of the Law and thus affecting the quality of SEA (Stojanović, Spasić, 2006).

Some of the first experiences in the implementation of this instrument in practice indicate that the decisions for SEA were usually made automatically and the whole procedure takes a long time (Josimović, Crnčević, 2006). However, even after several years of noticeable results in the practice still the main problem is non-existing of an adequate system of indicators while available Guidelines for SEA from 2007 do not cover all phases of SEA and do not have the connection to the current Law on planning and building (Stojanović, Mitrović, 2007). In addition, what should be pointed that so far has not been done anything significant in terms of strengthening the process where only some results have been achieved in terms of the quality of the SEA Report, what proves that there are tendencies towards the establishment of SEA as an administrative instrument, without important influence to the planning process (Crnčević, 2009).

The results from practice are of the great importance as they steer the development of this instrument towards innovation within methodological and procedural frameworks. Presented overview of practice - the SEA for the Waste Management Regional Plan for 11 Municipalities in Kolubara region represent the continuation of the research results presented in the paper: *Impact evaluation within Strategic Environmental Assessment: The Case Study of the Waste Management Regional Plan for Kolubara region in Serbia* (Josimović, Crnčević, 2009).

2. Implementation of SEA in Serbia

Within the Law on SEA in 2004 for the first time in Serbia, began implementation one of the most important instrument for the realization of the goals of sustainable development and environmental protection. The Law on SEA defines the procedure (stages in the process of SEA) contents and partly methodological framework.
As for the procedural framework, within the Law on SEA are set out the following phases in the SEA process:

1. Preparatory phase:
   - Deciding on the SEA,
   - Selection of the holder for making the report on SEA,
   - Participation of interested parties - agencies and organizations.
   - Procedures for preparing the SEA report.
2. Decision-making:
   - Participation of interested parties - agencies and organizations,
   - Public participation,
   - Report on the results of the participation of interested parties - agencies and organizations and the public,
   - Assessment of the SEA report,
   - Approval for SEA report.

For each of these phases it is defined who are the participants in the decision making process while the selection of the holder for SEA report is done for each SEA individually. This part of the Law on SEA is clear. That can be said also for the part of the Law related to the content of the SEA the content is divided into nine units:

1. starting points for SEA,
2. general and specific objectives of the SEA and selection of indicators,
3. assessment of potential impacts with the description of measures planned to reduce negative impacts on the environment,
4. guidelines for the SEAs for the lower hierarchy levels and environmental assessment,
5. program of environmental monitoring during the implementation of plans and programs (monitoring),
6. overview of the methodology used as well the difficulties in making SEA,
7. review of the ways of decision making, description of key reasons for the selection of the subject plan and programme of considering variant and presentation of the way how environmental issues are included in the plan or program,
8. conclusions to which were come during the preparation of SEA presented in a way that is understandable to the public,
9. other information relevant to the SEA.

SEA development in Serbia is based on the EU and worldwide experiences and so far little was done to develop the given methodological framework of the Law on SEA. One of the results in this regard so far achieved in Serbia is the result of the project' Methods for SEA in planning spatial development of the lignite basins''. The project was done at the Institute of Architecture and Urban Planning of Serbia (IAUS) in Belgrade and funded by the Ministry of Science and Environmental Protection Republic of Serbia in the period from 2005 to 2007. The result of this project is the defined impact assessment methodology that is based on qualitative multycriteria expert evaluation of plan and programme solutions regard to the

environmental quality in the area of the plan, the immediate and wider environment as a basis for evaluation of the area for further sustainable development (Fig. 1).
In the previous practice of SEA in planning, two approaches were dominant:

1. Technical: represent an extension of the environmental impact methodology for the EIA projects to the plans and programs where it is not a problem to apply EIA principles, and
2. Planning: represent a significantly different methodology for the following reasons:
   - plans are more complex than projects, they focus on strategic issues, and carry less detailed information on the environment,
   - plans are based on the concept of sustainable development, and apart from the ecological aspect, they largely focus on social and economic aspects,
   - due to the complexity of structures and processes, and their cumulative effects, planning does not allow sophisticated simulative mathematical methods,
   - decision-making processes involve a greater influence of the interested parties, especially of the public, and therefore the applied methods and assessment results must be comprehensible to the participants in the assessment study.

For the above-stated reasons, in the practice of the SEA, the most frequent expert methods are: control lists and questionnaires, matrixes, multi-criterion analyses, spatial analyses, SWOT analyses, Delphi method, evaluation of ecological capacity, analyses of cause and effect, vulnerability assessment, risk assessment, etc. Matrixes, as resultants of any of the methods, are used to analyze the changes that may be caused by the implementation of plan and chosen options (including the option not to implement the plan). Matrixes are formed by establishing the connections between plan targets, plan solutions and goals of strategic assessment with appropriate indicators.
The methodological approach shown in Fig. 1 is based on planning approach and expert evaluation and as well formation of matrix used to examine and to show changes in the environment. The aforementioned methodological approach has proved its worth by using in practice in the design of some 30 SEA reports for all types of spatial and urban plans that exist in the legislation of the Republic of Serbia. However, in practice, it was showed that matrix display of appearances and changes are often not understandable to the public that is interested to get involved in the process of SEA. This was especially confirmed in the stages of public participation, where participants who are not experts in this field are not able to understand the results that have been screened using the grid. Also, special attention is paid to the selection of relevant indicators and as well the criteria for evaluation of planning solutions, the method for evaluation and the way for presentation of the evaluated of planning solutions in a way that are comprehensible to the public. The research results were used in the SEA process for the first sector SEA for the Regional Waste Management for Kolubarski Region.

3. Implementation of SEA for the Regional Waste Management Plan for Kolubara region

SEA Directive provides that the SEA has to be done for plans and programs in different subject areas, including waste management. This is stated within the propositions of the Law on SEA of the Republic of Serbia. By applying the SEA in the planning of waste management is now possible to consider the consequences of proposed solutions and

planned changes in the region, respecting the environment including defining appropriate measures for protection and monitoring of potentially vulnerable elements of the environment, involving the public in all phases of SEA process, including adoption. In this context, it is evident that SEA contributes to the decision-making process in planning of waste management.

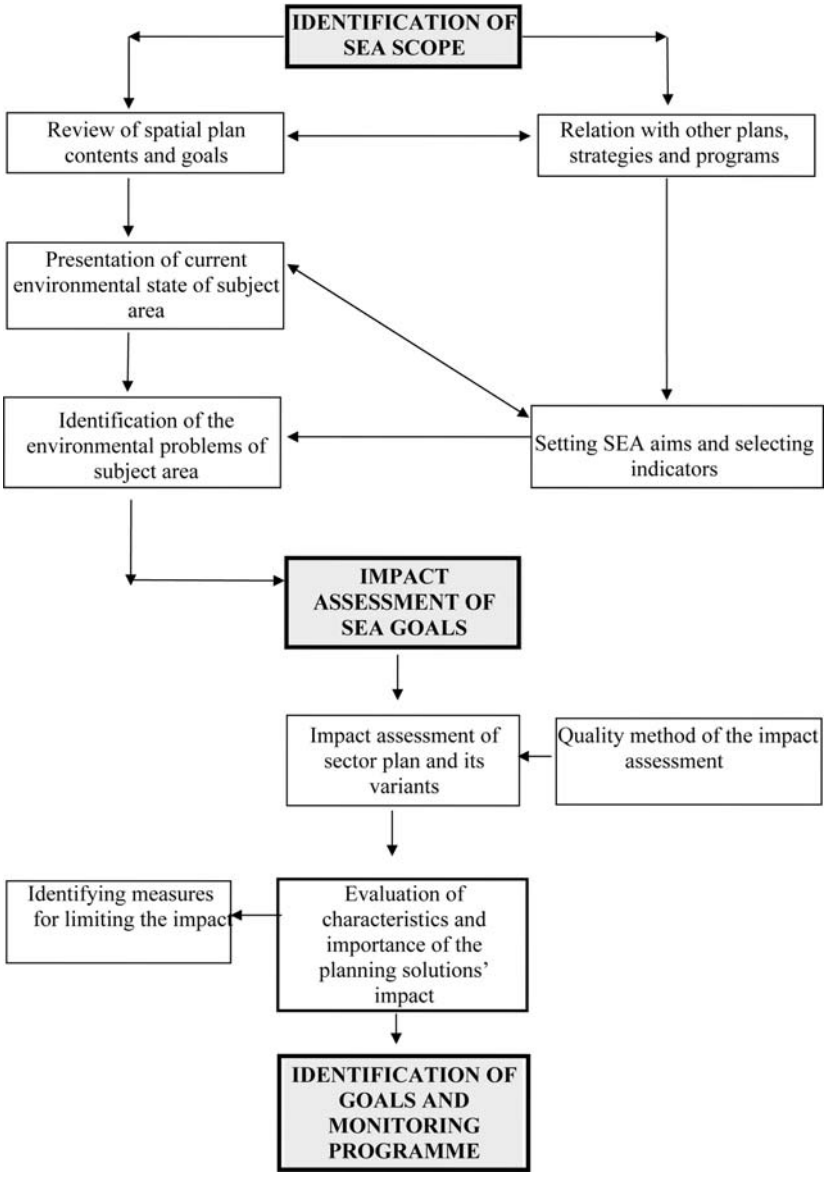

Fig. 1. Procedure and methodology of SEA reports (Stojanović, 2006)

Regional waste management plan for the Kolubara region was first of this kind at the territory of the Republic of Serbia. Is was the result of a wide range of activities that have been launched to address issues of treatment of waste and the establishment of a regional waste management concept. The plan covers 11 municipalities with over 380,000 inhabitants (Table 1).

Municipality	**Surface (in km²)**	**Population (Census 2002)**	**Density (inh./km 2)**	**Change of the no. inh. in the period '91.-'02 (in ‰)**	**The number of villages**	**Number of households**	**Average household size**
Valjevo	905	96761	107	0,2	73	33081	2,9
Ub	456	32104	70	-3,4	38	10056	3,2
Lajkovac	186	17062	92	-2	19	5605	3,0
Ljig	279	14629	52,5	-6,2	27	4757	3,1
Mionica	329	16513	50	-3	36	5091	3,2
Osečina	319	15135	47	-8,1	20	4696	3,2
Vladimirci	338	20373	60	-6,6	29	6687	3,0
Koceljeva	257	15636	61	-5,3	17	4900	3,2
Barajevo	213	26641	125	15,2	13	8646	3,1
Lazarevac	384	58511	152	1	33	18802	3,1
Obrenovac	410	70975	173	4,4	29	22836	3,1
Σ	**4076**	**384340**	**94,3**	**/**	**334**	**125157**	**3,1**

Table 1. Main data of the Kolubara Region

After obtaining the decision to work on Regional plan and on SEA for the plan from the competent institutions, started the process. Taking into account that the procedural part of the decision making for SEA was conducted in accordance with the legislation, in the continuation of the paper the emphasis was put on the presentation of the methodological approach that was used for the evaluation of planning decisions.

3.1 Methodological approach in SEA

Methodological approach in SEA for the Regional waste management plan is based on:

- analysis of the environment[1],
- selection of the most important planning decision in respect to the environment,
- defining the aims of the SEA and selection of indicators and criteria,
- assessment of the potential impacts of planning solutions in relation to defined aims and indicators,

[1]In the analysis of the state of the environment, but also in the process of determining of the strategic guidelines presented in the form of specific planning solutions major role is having application of GIS (Geographic Information System). GIS is used to analyze the state and visualization of the space by which in a fast and easy way perceive and shows the appearances of the area. The application of GIS in the subject pland by implementing the system of elimination the negative areas was defined the most important planning solutions - Regional Centre for Waste Management (Josimović, Krunić, 2008).

- defining the measures for protection and monitoring,
- conclusions and recommendations of the SEA.

Each of these steps are particularly important. In relation to the current state of the environment the aims are defined, and in relation to them indicators used when assessing the impacts of planning solutions on the environment and the elements of sustainable development. For the assessment of the impacts could be used qualitative or quantitative methods depending on the specific situation and the possibility of using one or another method. After impact assessment, the necessary protective measures are defined that need to be implemented during the implementation of the strategy for waste management so that possible harmful effects of the plan will be reduced to the limits of acceptability that will not burden the storage capacity and threaten the health of the inhabitants.

A special contribution in decision making at all levels of SEA for the waste management plan, but also for all other plans is the participation of qualified (professional) public. Under a qualified public is consider participation of interested institutions and organizations, non-governmental organizations (NGOs), local communities and professional individuals who can contribute in making key decisions within the selection of specific alternative scenarios in the plan. This does not exclude the participation of the population within the plan area which might be affected and which are not particularly qualified for this issue. Therefore, the implementation of SEA in Serbia is a good starting point for enhancement of public participation in planning where the „Plan for public participation" could be the way of operationalizing and moving the public towards more active participation (Crnčević, 2007).

When the SEA process is conducted after the main methodological steps and when are consider all alternatives and variant solutions, usually it is possible[2] to choose the best solution and incorporate it in the plan (strategy) of waste management in order to protect the basic elements of the environment and the realization of the goals for sustainable development of the area.

The most important steps in this methodological approach are shown below as (Josimović, Crnčević, 2006):

- defining goals of SEA and selection of indicators,
- assessment of the impacts of the planning solutions to the environment,
- definition of mitigation measures,
- definition of indicators for monitoring the state of the environment (monitoring).

3.1.1 Defining SEA aims and indicators

Defining SEA aims is conditioned by the grade of the current state of the environment, a preliminary assessment of possible impacts of planning decisions on the environment, the aims defined in the framework of other programs and strategies relevant to the issue of waste management and environmental protection. Aims are set in relation to environmental receptors, and for each is determined the appropriate indicator that is used to evaluate planning solutions. Selection of SEA aims and targets and the relevant indicators is shown in Table 2.

[2]The implementation of SEA process does not necessarily give the best solution. That was the case within SEA for Waste Management Plan in Salzburg. In this case SEA process was focused on the identification"for"and"against" alternatives without finding the best solution. After analyzing a large number of separate results of SEA, it was not possible to determine which inputs (political) will have some of planning solutions. In this case, final decisions are made at the political level where often are decisive conclusions which were adopted after a process of public participation.

The receptors of the environment	SEA aims	SEA targets	Indicators
Water (surface and underground)	Reducing the pollution of underground waters to the level that the negative impacts do not exist.	- Realising of harmful substances from the activities of operating with waste in water has to in accordance with limited value of the emission (LVE). - Provide that the quality of water downstream from the installation not became worse.	- The number of installations which are crossing LVE in water. - Biological consumption of oxygen (BCO) and chemical consumption of oxygen (CCO) upstream and down stream from the installation for waste management.
Air and climatic changes	Limit the emission of harmful substances in the air to the level that negative impacts to the quality do not exist.	- Realising the harmful substances in the air from the activities of operating with waste has to be in the accordance with LVE. - Increase the scope of collected communal waste - Reduce non controlled burning/disposal of waste. - Maximise potentials for getting energy from the installations for waste management.	- The number of days when is violated LVE of dust, NO_x, SO_2. - The number of trash dumps which are the source of air pollution. - The percent of inhabitants covering the system of waste collection. - The estimate amount of not collected waste.
	Reduce the impacts of gases which are influencing the greenhouse effect.	- Reduce the emissions of CH_4 and CO_2 from installations for waste management. - Fulfil national aims for waste management including the using of gas from the landfill.	- The amount of the waste which is recycling, laying down to the landfill or is in the other way treated. - The estimate year emission of gases from the landfill (CO_2, CH_4).
Land	Limit the use of cultivable agricultural land.	- The surface and quality of the land which is using for the activities for waste management (per tone of waste) has to be in the accordance with best practice.	- The surface of land taken with the activities of handling with waste.
	Reduce land pollution.	- New installations build to the non sensitive locations. - Minimize the land surface polluted as a result of the activities with waste. - Carry out the rehabilitation of the trash dumps and recultivation of the land.	- Location of new installations and relation of surfaces of existing and planed surfaces under the landfills. - The surface of land polluted because of the activities handling with waste. - The surface of land which is restored.
Biodiversity	Reduce negative impact to the biodiversity.	- Provide measures of compensation for every damage done to the habitat. - New installations built to the non sensitive locations.	- The closeness of new installations for waste management to the sensitive reas. - The percentage of habitats damaged because of the activities of handling with waste.

The receptors of the environment	SEA aims	SEA targets	Indicators
Landscape population and human health	Protect the landscape and natural properties.	- Protect the landscape - carefully choice the location for new installation for waste management. - Maximise rehabilitation of closed trash dumps for landscape protection - Minimise non adequate handling with waste.	- The number of place endanger with installation for waste management. - The surface which is rebuild. - The number of the inspection records of wild dumps and non adequate handling with waste.
	Protection of human health.	- Minimise risks and impacts from accident emissions resulting from the activities handling with waste. - Minimize the level of environmental problems resulting from the activities of waste management. - Establish criteria for landscape protection for choosing the location for installation of waste disposal.	- The number of the inhabitants which became ill from the consequences of non adequate waste disposal. - The number of complaints of citizens because of the environmental problems resulting from the activities handling with waste. - The closeness of the installations for waste management to the inhabitant places.
	To induce economic development and employment brought in the region.	- Inducing opening of new working places within the process waste management.	- The number of new working places. - Profit from the realization of the project.
Traffic	Minimizing the impacts to the environment from the waste transport.	- Reduce the scope of traffic from waste transport. - Include the principle of cleanness as much as possible for the activities for waste management - Minimize making of waste as a result of reducing the waste transport.	- The number of the crossed km because of the waste transport. - The nearness of the installations for waste management to the inhabitant places.

Table 2. Receptors, aims, targets and indicators (Josimović, 2010)

In Table 2. are presented the goals and indicators for SEA of Regional Waste Management Plan for 11 municipalities of Kolubara region. Selection of SEA aims and indicators is based on the United Nations (UN) basic set of indicators of sustainable development and defined in relation to the current state of the environment and the basic concept of the plan and planning solutions. In this context, special attention is devoted to analysis and evaluation of basic planning solution in the system of waste management and that is certainly the formation of a regional centre for waste management in which is planned regional landfill with additional objects that are in function to the landfill (waste separation facility, baling, processing waste). In addition to the locating of regional centre for the management of

waste in the SEA are analyzed and evaluated other planning solutions for which area also defined appropriate aims and indicators. These planning solutions are: transfer stations, recycling centres and other facilities for waste treatment, transport costs, the extension includes waste collection, the establishment of companies in whose responsibilities will be activities related to the management system and creating conditions for employment and others.
In relation to defined SEA aims and indicators it was carried out evaluation of the selected planning solutions.

3.2 Assessing the impact of planning decisions on the environment

In order to perform the evaluation of the plan in relation to the elements of sustainable development, it is necessary to make the selection of relevant planning solutions that will be evaluated and as well define the evaluation criteria.
Bearing in mind the characteristics of the planned uses, for the need of the evaluation of the Plan are separated planned solutions shown in Table 3.

Mark	Planned solution
Establishing a system of integrated and sustainable waste management	
1.	Waste transport
2.	Construction of transfer stations
3.	Building a recycling yard
4.	Closing and rehabilitation of existing municipal landfills - dumps
Regional Centre for Waste Management	
5.	Regional landfill
6.	Facility for recycling (waste separation)
7.	Composting facility for green waste
8.	Plant for mechanical biological waste treatment
9.	Plant for recycling construction waste

Table 3. Plan solutions included in the evaluation process

Planning solutions that are selected for evaluation are divided into two main groups (Table 3): system planning solutions and planning solutions which are related to the establishment of a regional centre for waste management. Selected planning solutions assume the physical elements of the future of waste management system, or specific facilities to be built in the area of plan coverage. In that context their potential impact on environmental quality may be most evident. Other planned solutions are related primarily to strategic management policies that do not have a significant impact on the quality of the environment.
In order to adequate evaluate the planning solutions in relation to defined SEA aims and indicators, it is necessary to establish adequate criteria for evaluation. In practice with different methods of evaluation and assessment and analytical procedures, it was proven that multicriteria analysis and evaluation gives better results compared to the evaluation with only one criterion. This is logical because with multi-criteria analysis and evaluation are obtained multidimensional results whose synthesis gives more relevant testimony. In this context, in the process of evaluating the selected planning solution it is used multicriteria evaluation criteria defined in Table 4.

Kind of the impact	Spatial dimension of the impact	Probability of the impact	Frequency of impact
Very favourable (+3) **Favourable (+2)** Positive (+1) Neutral (0) Negative (-1) **Unfavourable (-2)** **Very negative (-3)**	**Regional (R)** **Municipal (M)** Local (L)	Quite sure (Q) Likely (Lk) Possible (Ps) Unlikely (U)	Temporary (T) Long-term (Lt)

Table 4. The criteria for evaluation of impact significance

The importance of the impact of planning solutions is assessed in relation to the size (intensity) and spatial scale where the impact can be achieved. Impacts or effects of planning solutions, by the size of the change are evaluated with numbers from -3 to +3, where the minus sign refers to negative, and a plus sign for positive change. Spatial scale may be regional (R), Municipal (M) or local (L) character. The probability that an estimated impact will happen in reality is also an important criterion for making decisions in the course of the plan making, and in that context impacts can be quite sure (Q), likely (Lk), possible (Ps) or unlikely (U). This system of evaluation is applied both to the individual indicators of impact and, as well to the related categories of the combined indicators. In addition, additional criteria can be derived according to the duration of the impact or consequences. In this sense can be defined as temporary (T) and long-term (Lt) effects.

Based on the criteria of the assessment of the size and spatial scale of the influence of planning solutions at the SEA aims it was carried out a qualitative expert evaluation of the importance of the impacts for achieving these goals. The impacts of strategic importance for the subject plan are these which have a strong or greater (positive or negative) effect on the whole area of the plan or at the municipal level (e.g. in the range of -2, -3, +2, +3, and R or M).

For each of the selected solution is considered approach of evaluation in relation to defined aims, indicators and criteria. Evaluation is done in two phases:

- Creating a chart - where for each planned solution are show trends in relation to the key criteria which classify significant strategic impact and those who do not have strategic importance and
- Forming synthesis table - which determines and rank the strategic impact on the basis of criteria defined in Table 4.

Chart (Figure 2) is formed for each of the nine selected planning solutions. It shows kind of impact (x-axis) and spatial extent of influence (shown in different colours depending on whether the impact is of regional, municipal or local level. Characteristics of impact are defined in relation to the twenty-four defined SEA aims and indicators shown in Table 2. The aims are on the chart shown on the y-axis.

In previous research conducted by the authors, were used instead of a chart a table (matrix) to show the possible impacts of planning solutions. However, practice showed that matrix display is not completely clear to the experts and especially to the public. By formatting the graphs this problem is overcome because at first glance it could be seen the intensity of positive and negative impacts of each plan solutions and as well spatial scale of influence in

relation to each of the defined aims. In fact, all the positive effects are on the right, and negative on the left y-axis, and colour space determines the scale of these impacts. After an evaluation of the impacts of planning solutions presented by charts, starts the identification and evaluation of the impacts of significant strategic planning solutions by synthesizes of the key impacts of the plan to the defined SEA aims and criteria from Table 4. For every planning solution which is designated as of significant strategic importance are presented the rank of impact in relation to the SEA aims and four sets of criteria for evaluation (Table 5).

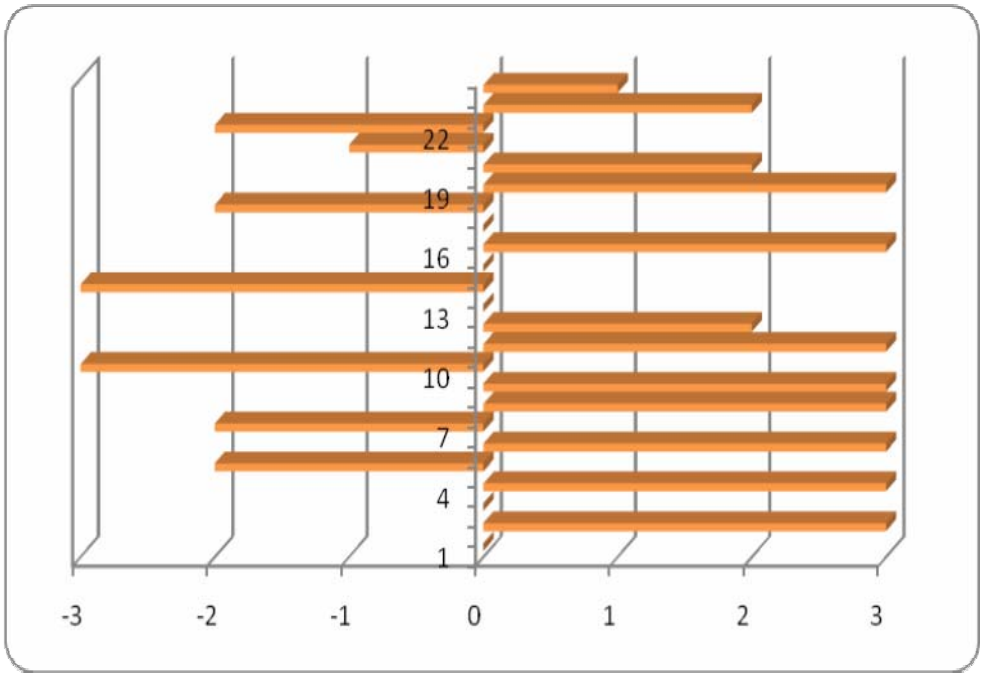

Fig. 2. Chart formed for each of the nine selected planning solutions.

Based on the identification and evaluation of the impacts of significant strategic planning solutions the conclusion is brought on what impacts the implementation of the plan initiates in the planning area and in relation to environmental and socio economic issues. In this context, it is now possible to define appropriate measures for protection and monitoring which allows the effects to be reduced in scope that does not burden the storage capacity.

After identification of significant strategic impacts it is possible to define the cumulative and synergetic effects. Significant effects can occur as a result of interactions between a number of smaller impacts of existing facilities and activities, and various planned activities in the area of the plan. Cumulative effects arise when particular planning solutions have significant impacts, while some single effects together may have a significant effect. Synergetic effects are created in the interaction of individual impacts that produce the overall effect that is greater than the simple sum of individual impacts.

PLAN SOLUTION	IMPACT		EXPLANATION
	SEA aim	Rank	
WASTE TRANSPORT	4	M/+3/Q/Lt	Expansion of the collection of waste will have multiple positive long-term effects on the environment. Possible occasional negative impacts could be of the distance transport.
	8	R/+3/Q/Lt	
	22	R/-2/Ps/Lt	
⋮	⋮	⋮	⋮
REGIONAL LANDFILL	4	R/+3/Lk/Lt	The regional landfill is among the most significant planned facilities. Its construction will have major positive effects on the environment since it will replace a large number of existing city dumps. Bearing in mind that it will be built in the degraded area and according to the EU Landfill Directive 99/31 its importance for environmental protection of the wider area is very considerable. The occasional negative effects can be expected from the distance transport of municipal waste to the regional landfill with regard that this type of transport has not been implemented yet. Looking at the broader context, the positive effects of the construction of regional landfills are much larger than these occasional adverse effects. Contribution is reflected in job creation. Landfill will be located in a regional centre for waste management.
	5	R/+3/Q/Lt	
	6	O/+3/Q/Lt	
	8	R/+3/Q/Lt	
	11	R/+3/Q/Lt	
	12	R/+2/Q/Lt	
	14	R/+3/Q/Lt	
	16	R/+3/Q/Lt	
	18	R/+2/Q/Lt	
	20	O/+2/Q/Lt	
	22	R/-2/Lk/T	
	23	R/+2/Q/Lt	
⋮	⋮	⋮	⋮
n	⋮	⋮	⋮

Table 5. Identification of strategic impacts of plan solutions to the environment and elements of sustainable development

Part of the system of waste management	**Plan solutions**	**Consideration of the impact**
Collection and waste transport	Transfer station	benefit for the environment, potential negative impacts on the environment, measures to mitigate negative impacts.
	Transport	
Recycling of waste	Recycling plant	
Composting of Waste	Plant for composting	
Mechanical-biological waste treatment	Plant for mechanical biological waste treatment	
Waste disposal	Regional Landfill	
	Closing the landfill	

Table 6. Consideration of the impacts of Plan solutions and the definition of protection measures

Possible effects of all planning solutions are considered including three main aspects: benefits and possible negative effects on the environment, defining measures for mitigation of the negative impacts that may arise as a result of planning solutions. The approach which was used is specific because it is showing as well concrete benefits to the environment of

each of the planning solution, which is especially important for all participants in the planning process for waste management. Thus, for example by implementation of the Regional Waste Management Plan in the area of the Kolubara region instead of 11 non-sanitary landfills and dozens of illegal dump sites in the territory of each municipality will be located just one sanitary landfill, which will thereby be located in the area with completely degraded environment (surface area of coal exploitation). Benefits to the environment are evident in this context and incalculable. As a logical continuation of this process is defining the monitoring program for the key environmental factors (Table 7).

According to the Law on Environmental Protection of Serbia, the quality of the environment is defined as the set of natural and man-made values, whose complex interrelationships make up the environment, actually the space and conditions for living, as the state of environment which is expressed by physical, chemical, biological, aesthetic and other indicators. But, the law does not define the term indicators, and in practice indicators appear with different interpretations and applications. In Serbia, the indicators commonly referred to as data relating to the quality of air, water and soil. However, contemporary approach of the European Environment Agency (European Environmental Agency, EEA)[3] is based on complex DPSIR (driving force-pressure-state-impact-response) concept, which takes into account all the phenomena in a causal chain, including the response in unsatisfactory condition. This concept implies an active attitude toward the changes in the environment, including socio-economic aspects, which are often the driving force of changes. In this way a purely "environmental indicators" are included in the system of indicators of "sustainable development" (Josimović, 2010).

The aforementioned concept is basically used in the phase of formulating of SEA aims and indicators, as a means for monitoring progress in achieving the aims of the plan and SEA. After, it was selected key indicators to be used for monitoring the achievement of SEA aims or the state of the environment during the implementation of the plan. The aims and indicators have been developed during the SEA process in consultation with the authorities responsible for environment and corrected during the process. SEA aims used to evaluate the Plan are having associated indicators, some of which are considered significant such as water quality, air quality, climate change and transport.

Recommendations related to monitoring are:

- it is recommended to establish monitoring of indicators and to report regularly; these information can serve as a basis for future Plan;
- avoiding duplication of activities; most of the indicators are based on existing data – therefore the data are used for comparison and reporting;
- indicators should be compared and monitored annually and integrated into the annual report on the implementation of the Waste Management Plan;
- monitoring is a continuous process and performance indicators should be improved or added over time if required;
- there must be a commitment of the authorities to create the resources available to conduct monitoring for the duration of the Plan;
- to explore opportunities for co-ordination of persons who process data regarding the best utilization of available data;
- indicators include values relating to the waste, as well as tones of non collected waste and the appearance of uncontrolled burning and illegal dumps.

[3] EEA, Technical Report No25, Environmental Indicators:Typology and overview, *Copenhagen:EEA,1999)

Receptors of the environment	Indicators	Competent authorities for monitoring	The frequency of monitoring	Unexpected negative impacts - require additional measures
Water	- Number of facilities that exceed the water LVE. - BCO and CCO upstream and downstream of the plant for waste management. - Number of accidental pollution of water for which there is a report (e.g. plague fish)	Department of Public health Republic environmental inspections	Annual	- 10% of increase - Reducing class of water flows downstream. - 10% increase in reported accidents.
Air and climate change	- Number of days when it exceeded LVE dust, NOx, SO2. - Estimated amount of not collected waste.	Department of Public Health Department for municipal affairs	Annual	- 10% of excess - Increase the amount of non collected waste
	- The amount of waste that is recycled, that goes to the landfill or it is otherwise treated. - The calculated annual gas emissions from landfills (SO2).	Environmental Protection Agency Department for municipal affairs	Annual	- The lack of progress in relation to the objectives of the Plan. - No reduction of gas.
Land	- Area of rehabilitated land.	Environmental Protection Agency	Every second year	- The lack of progress in the implementation of the Plan.
Biodiversity	- Proximity of new waste management facilities for sensitive areas.	Institute for nature protection	Every second year	- Increase in the loss of habitat.
Region	- Number of existence of vulnerable sites.	Institute for nature protection	Every second year	- Increase in the number of endangered places.
Population and human health	- Number of people suffering from the consequences of inadequate waste disposal. - Number of complaints from citizens because of: noise, odours and environmental problems due to the activities of dealing with waste.	Institute for Public Health	Every second year	- Increase the number of infected people. - 10% increase in the number of complaints.
Traffic	- Number of driven km for transportation of waste. - Quantity of waste.	Department for communal and inspection occupation of the municipalities	Every second year	- Set a goal after the first collected data . - Less than 5% in decreasing waste.
Waste	- Number of reported accidents: illegal landfills, burning in the yard, the other.	Republic environmental inspection	Annually	- 10% increase in reported accidents.

Table 7. Indicators and the authorities responsible for environmental monitoring (Josimović, 2010)

In Table 7. are shown indicators and the competent authorities for monitor the environmental situation in the area covered by Regional waste management plan of the Kolubara region. Monitoring program is developed and key indicators have been established for water, air quality, climate change and transport. These are aspects of the environment in which the implementation plan is likely to have impact. An additional set of indicators includes indicators that are not affected significantly. This refers to biodiversity, landscapes and so on. Additionally to the above mentioned it has to be stated that the presented SEA is found to promote quite balanced sustainability, with the lowest score found within social benefits and the highest in economical (Crnčević, Therivel, 2009).

4. Conclusions

The paper emphasis is put on presenting methodological approach was develop for SEA of the Regional Waste Management Plan for 11 municipalities of Kolubara region, which is made in the Institute of Architecture and Urban and Spatial Planning of Serbia. It was used planning approach where aims and indicators are defined and evaluated in the context of the realization of the plan solution and not technological. The presented methodology is based on the experience of making SEA in developed countries, because even after more then five years after the adoption of the SEA in Serbia still missing the adequate Regulations as well guidelines which would help experts in developing methodological approach for SEA. The presented methodological approach is based on multicriterion evaluation of planning solutions in respect to the defined SEA aims and indicators of sustainable development. It was used qualitative evaluations based on expert knowledge and professional literature. Within the research were defined 24 indicators to evaluate planning solutions that can have an impact on the environment as well the evaluation of existing conditions for the analysis of existing potentials and was made a qualitative assessment of the impacts of planned activities on these potentials. The appropriate protective measures are defined and as well indicators for monitoring of the state of the environment. In SEA presented in this paper were defined 15 indicators for monitoring. The aforementioned methodological approach is broadly applicable to all areas of planning, but the concrete contribution of the presented SEA is seen in the choice of relevant aims and indicators based on the basic principles of waste management plan.

Way of selecting and displaying significant strategic impacts through the chart as presented allows easy access to the results of the evaluation process and make the presentation of the project easier. The results of the assessment of the planning solutions represent a good basis for determining appropriate measures for environmental protection and guiding of planning solutions in the context of achieving the desired goals. That is exactly the main task of SEA and the aforementioned model that will certainly be developed over time. Minor problems have been shown due to the lack of national databases, relevant data about the environment, so their availability varied depending on the measurements which are (not) being done in some municipalities. To overcome this problem it was implemented the program called CORINA - the unique European information base about the environment and the use of space (Fig 3). It is also used the internal informational basis in GIS, formed in IAUS for the needs of spatial plans. The system supported by such information base made it possible relatively high quality and rapid analysis of environmental data on the researched area (Josimović, Ilić, Filipović, 2009).

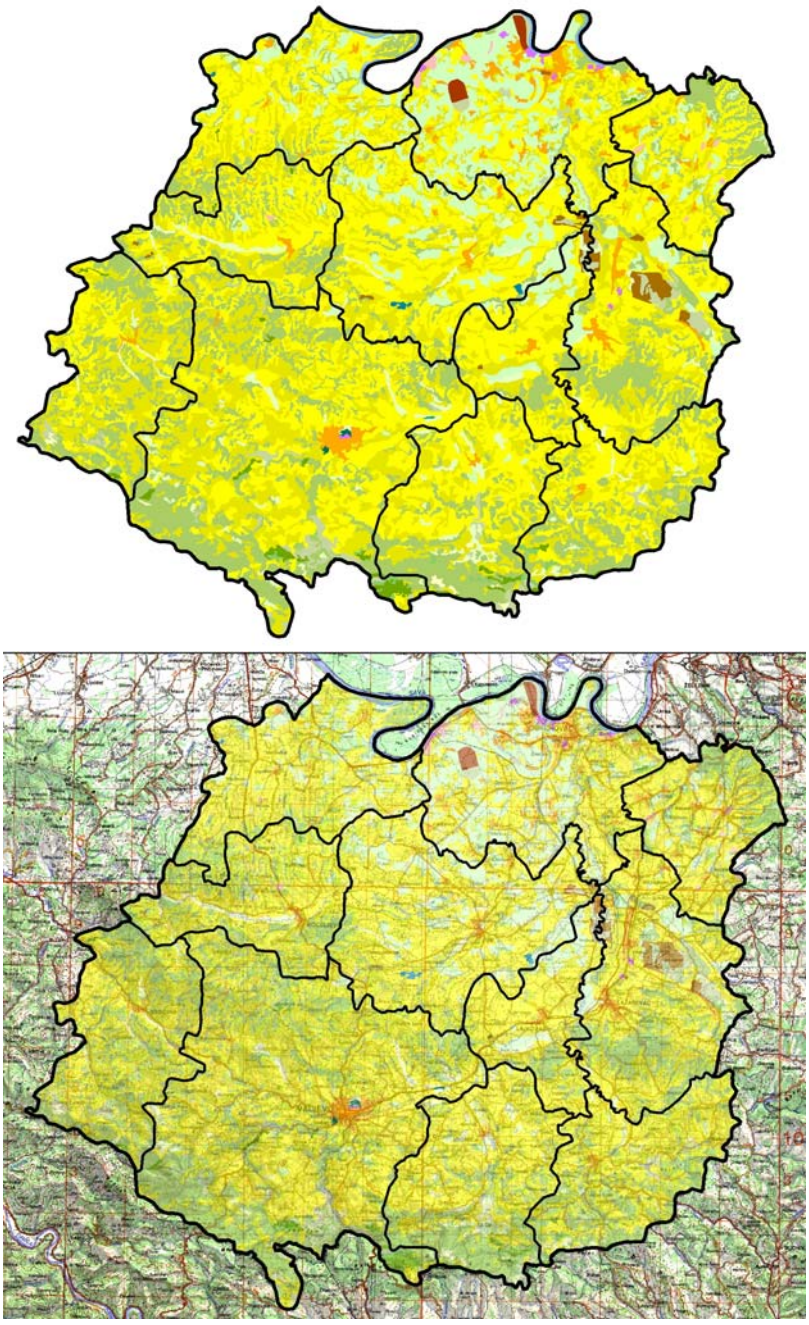

Fig. 3. CORINE map for Kolubara region

Scientific contribution of this work is reflected in the adjustment of SEA methodology (developed in IAUS) for the presented sectoral regional waste management plan where applied methodology can be used for other plans and programs for waste management in different hierarchy levels. Adjustments are primarily related to the selection of relevant strategic aims and indicators in the context of the current state of the environment in the planning area and the possible negative impacts of the plan to the environment, but also how the evaluation is presented using the chart.

Directions for future research in environmental protection in the field of waste management should include following:

- development of information base of the space which will form the basis for effective environmental protection,
- development of indicators adapted to the needs of the SEA,
- development of indicators in the function for monitoring the environment in areas where are established systems of waste management
- the implementation of the education program of the population on contemporary principles and technologies of waste management treatment and waste disposal in order to reduce resistance of the population which is particularly evident in the location of landfill space.

The implementation of these settings would contribute to the systematic and methodological problem solving of environmental management in the planning and development of the SEA and completed the researches of spatial aspects of waste management. So by this way this issue will be seen from the perspective that in the spatial sense enables the establishment of modern waste management system based on a good (effective) organization of space with the protection of all environmental factors.

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5

Incentives of Environmental Design and Management in Urban Neighborhoods

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1. Introduction

Historically, many planning policies have been implemented to protect urban residential environments, such as controls of land use change, regulations of green space, and protection of landscapes. The importance of effective environmental management has been recognized not only for its ability to enhance a sense of community identity, but also for creating added value in residential areas (Adams & Leedy, 1987; de Haas et al., 1999; Jim, 2004; Murtagh, 1997).

Since the period of Reform and Opening in the late 1970s, China has been transforming from a planned economy to a market economy. With rapid development for over 30 years in urban areas, the quality of life of city-dwellers has greatly improved and the need for desirable and high-profile residential environments has increased accordingly. In the process of large-scale urban development, many new issues have surfaced, such as the sharp change of urban landscapes and the dilapidation of old neighborhoods. For instance, during the period of the welfare-housing system, most people lived in gated housing blocks maintained and managed by their work units. In 1998, the system of allocating free housing to employees through their work units was abolished, and it shifted to the allocation of housing subsidies. Many residential blocks were commercialized and new inhabitants moved in. As work units no longer had any management responsibilities, the environments of many areas have suffered tremendously. The expanding gaps between new and old residential areas have significantly reduced the overall quality of urban environments and have resulted in more and more social problems. Therefore, it is critical to introduce a new market-based system of environmental management of residential areas, the benefits of which must be clarified.

2. Aims and method

This chapter attempts to explore the critical determinants of environmental management and clarify the benefits of environmental management using a micro-economic approach.

Many studies have been conducted in this field. For example, Lichfield (1988), Carter & Bramley (2002), Coeterier (2002), and İpekoğlu (2006) analyzed the value of preserving historic sites and traditional houses from the perspectives of urban forms and culture. Gómez-Sal (2003) compared the effects of different environmental management policies

using a landscape assessment system for residential areas consisting of ecological, economic, and social indices. Prato (2000) presented a model for evaluating landscape management schemes where a variety of ecological, economic, and policymaking attributes were considered. Groat (1984) investigated public opinions toward the contextual fit of urban space, providing the basis for planning and design rules for urban development.

In China, a great number of community-based evaluation systems of residential environment have been presented in which indices of location, abundance of green space, infrastructure and public facilities, housing price, and the social and economic attributes of residents are commonly included (Xie, 1997; Ning & Cha, 1999; Hua, 1999; Li & Ye, 1999; Chen et al., 2000; Li & Li, 2006; Wang et al., 2002; Wu et al., 2003; Zhang et al., 2004). However, these studies have not emphasized the quality of environmental management. Although sanitation, security, and landscape management in residential areas are thought to be important factors of environmental quality (Wu et al., 1995), quantitative studies on the economic value of environmental management are scarce.

This study is based on a site survey and an investigation of the previously-owned housing market in Beijing. First, we conducted a site survey in the sample area and studied the main determinants of environmental management in residential blocks using a factor analysis method. Then, a hedonic regression approach was adopted to estimate the benefit of environmental management from an analysis of housing prices.

3. Data

3.1 Study area

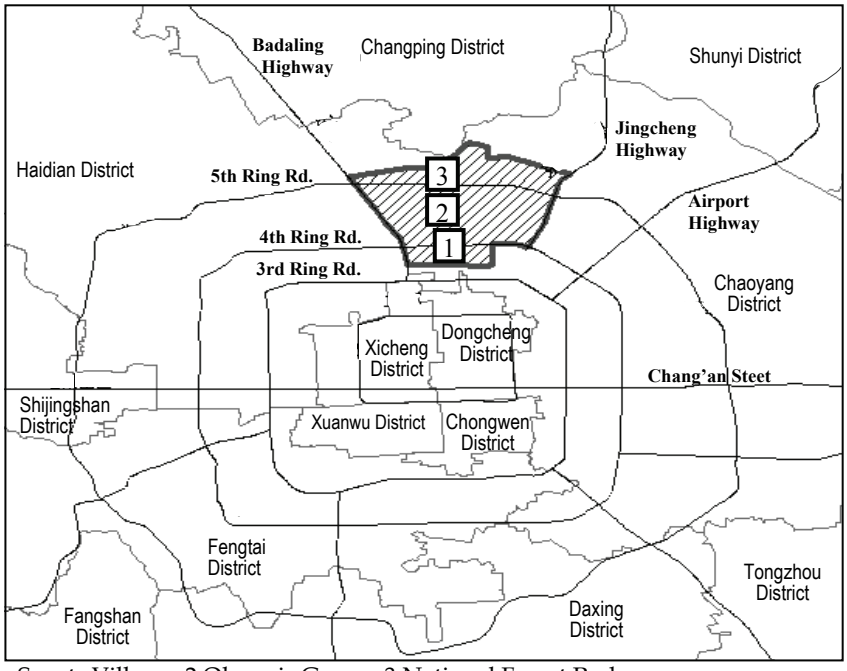
A basic assumption underlying the hedonic regression approach is that the valuations of environmental products are homogeneous in the study area. Therefore, the scope of the study area should be appropriately confined; otherwise, it is possible for the estimates to be affected by the differentiation of submarkets. Accordingly, the study area is limited to the Asian Sports Village and Olympic areas in Beijing (the shaded areas in Fig. 1).

Beijing has a typical mono-centric structure. There are five ring roads around the Forbidden City and several radical highways that form the main framework of the developed areas. The study area lies across the northern Fourth and Fifth Ring Roads, occupying about 25 km^2. It is next to highways in the east and west, and borders a river in the north and an arterial road in the south. The area is located around the Asian Sports Village (built for the 1992 Asian Olympic Games), the Olympic Green Center, and National Forest Park (constructed for the 2008 Olympic Games). There are a variety of residential compounds in this area, e.g., old neighborhoods built in the 1970s and 1980s, large communities constructed in the early 1990s, and new commercial housing blocks developed since 2000.

3.2 Site survey of residential blocks

We randomly chose 63 residential blocks and conducted a site survey, focusing on their environmental design and management situations. The characteristics of the blocks were captured from five perspectives: 'building design', 'planning', 'management', 'community', and 'surrounding relationship'. The survey involves 39 indices with scores of '+1', '0', and '-1'. Table 1 lists the content of the survey and the standard of scoring.

The survey was conducted in May, 2007. To ensure objectivity in the survey, a detailed manual was prepared, with concrete descriptions of the scoring standard and sample pictures for reference. In addition, the property fee levels of each residential block were investigated.



1 Asian Sports Village, 2 Olympic Green, 3 National Forest Park

Fig. 1. Location of sample area in Beijing

Group	Item	Content	Scoring standard
Building design (6)	Elevation design	Color, ratio, roof, silhouette, etc.	+1: good; 0: average; -1: poor
	Architectural style	Creativity, cultural meaning	+1: good; 0: average; -1: poor
	Exterior	Decoration materials	+1: good; 0: average; -1: poor
	Building management	Safeguards and monitoring systems	+1: complete; 0: simple; -1: none
	Ground plane design	Design of hall and entrance, connection with path and garden	+1: good; 0: average; -1: poor
	Barrier-free	Barrier-free design	+1: yes; 0: no
Planning (14)	Harmony of buildings	harmonious form, color, etc.	+1: good; 0: average; -1: poor
	Mixing building ages	Similar age, quality, etc.	+1: good; 0: average; -1: poor
	Mixing land use	Amount of industries and commercial use incompatible to residential use	+1: none; 0: some; -1: many
	Road system	Systematic and smooth	+1: good; 0: average; -1: poor
	Road quality	Pavement, sewage system, lighting, etc.	+1: good; 0: average; -1: poor
	Open space	Size and quality of public open space	+1: good; 0: average; -1: poor
	Central park	Size of central park	+1: good; 0: average; -1: poor
	Waterscape	Special design of waterscape	+1: yes; 0: no
	Garden	Garden design of public green space	+1: good; 0: average; -1: poor
	Details	Detail design of public space	+1: good; 0: average; -1: poor

Group	Item	Content	Scoring standard
	Sight focus	Sight focus design	+1: good; 0: average; -1: poor
	Facilities of public space	Variety and quality of public furniture and facilities	+1: good; 0: average; -1: poor
	Partitions and walls	Design of partitions and walls	+1: good; 0: average; -1: poor
	Electricity poles/lines	Style and layout design of electricity poles/lines	+1: underground; 0: tidy and above ground; -1: disorderly and above ground
Management (11)	Security	Entrance guard and monitoring	+1: strict and formal; 0: average; -1: poor
	Instructions and signs	Block maps, traffic signs, parking instructions, etc.	+1: good; 0: average; -1: poor
	Car parking	Management of car parking	+1: good; 0: average; -1: poor
	Bicycle parking	Management of bicycle parking	+1: good; 0: average; -1: poor
	Environmental sanitation	Garbage collection and sweeping	+1: very clean; 0: average; -1: dirty
	Maintenance of green areas	Maintenance of public green areas	+1: good; 0: average; -1: poor
	Maintenance of building appearance	Erosion, fading, peeling, etc.	+1: none; 0: some; -1: heavy
	Pasting and graffiti	Scribbles, doodles, stickers	+1: none; 0: some; -1: many
	Peddlers	Management of peddlers in the block	+1: good; 0: average: -1: poor
	Maintenance of public facilities	Fitness facilities, dustbins, etc.	+1: good; 0: average; -1: poor
	Informal structures	Shelters and informal buildings on balconies, etc.	+1: none; 0: some; -1: many
Community (2)	Information exchange	Community bulletin board	+1: good; 0: average; -1: poor
	Community atmosphere	Atmosphere of coexistence and communication	+1: good; 0: average; -1: poor
Surrounding relationship (6)	Neighboring service facilities	Continuity of shopping and service facilities, etc.	+1: integrated; 0: some; -1: separated
	Surrounding transportation	Influence of noise and pollution	+1: none; 0: some; -1: severe
	Surrounding building forms	Conformity in building height, style, etc.	+1: good; 0: average; -1: poor
	Surrounding road system	Integration of road system with surrounding blocks	+1: good; 0: average; -1: poor
	Openness to surrounding areas	Style of walls, gates, fences of the block	+1: open block; 0: semi-open; -1: completely closed
	Grade difference of blocks	difference in the quality of adjacent residential blocks	+1: little; 0: some; -1: large

Table 1. Survey items on the environmental design and management of residential blocks

4. Critical determinants of environmental management

4.1 Factor analysis

Among the data obtained from the site survey, the scores between different indices and those between different levels of the same index are not linear. In addition, many indices are

correlated. To obtain the critical factors of environmental management, the 39 indices have to be summarized. With the method of factor analysis, seven principal components with eigenvalues above 1 were composed, accounting for 78% of the variance of the 39 indices. After rotating the eigenvector matrix, seven factors were drawn (Table 2). According to their correlations with the original indices, we defined them as: (1) planning and design; (2) contextual fit; (3) property management; (4) conformity of urban design; (5) completeness of facilities; (6) surrounding influence; and (7) mixture of composition.

4.2 Classification of residential blocks by environmental type

The scores of each residential block were computed on the seven dimensions. Then, a cluster analysis was conducted with the factor scores. As a result, the 63 residential blocks were classified into 6 types. Their respective features are shown in Table 3. The average levels of property management fees were also given. It was found that the property management fee of type 1 is the lowest (1.05RMB/m^2 per month), followed by types 3, 2, 5, 4. The average fee of the 6th type is the highest (3.74RMB/m^2 per month). Quality of environmental management is correlated to property management fees: the fees are higher in residential blocks with better environments.

Factors	1	2	3	4	5	6	7
	Planning & design	contextual fit	property management	conformity of urban design	completeness of facilities	surrounding influences	mixture of composition
Elevation design	0.409	-0.006	0.536	-0.576	-0.180	-0.155	0.153
Architectural style	0.803	-0.077	0.263	-0.372	-0.036	-0.108	-0.011
Exterior	0.797	-0.002	0.256	-0.220	-0.178	0.085	0.005
Building management	0.633	-0.011	0.534	-0.238	0.047	0.110	0.278
Ground plane design	0.772	0.132	0.435	-0.239	0.165	-0.100	-0.059
Barrier-free	0.755	0.237	0.196	-0.328	0.115	-0.085	-0.029
Harmony of buildings	0.164	0.040	0.364	-0.734	0.006	-0.184	-0.217
Mixing building ages	0.187	0.152	0.294	-0.202	-0.006	-0.202	-0.765
Mixing land use	0.012	0.050	0.730	-0.309	0.308	-0.263	-0.093
Road system	0.208	-0.255	0.382	-0.371	0.029	-0.179	-0.503
Road quality	0.697	0.050	0.511	-0.036	-0.070	-0.092	-0.132
Open space	0.001	-0.188	0.676	-0.066	0.263	-0.192	-0.226
Central park	0.116	-0.432	0.075	-0.104	0.673	0.217	-0.026
Waterscape	0.299	0.088	-0.074	-0.378	0.392	0.010	-0.102
Garden	0.794	-0.202	0.193	0.081	0.287	-0.107	-0.193
Details	0.788	-0.320	0.040	-0.076	0.058	-0.201	-0.111
Sight focus	0.814	-0.186	-0.089	-0.047	0.197	0.034	-0.091

Factors	1	2	3	4	5	6	7
	Planning & design	contextual fit	property management	conformity of urban design	completeness of facilities	surrounding influences	mixture of composition
Facilities of public space	0.369	-0.323	0.235	-0.001	0.661	0.229	-0.008
Partitions and walls	0.748	-0.219	0.149	0.030	-0.133	-0.300	-0.140
Electric poles/lines	0.634	-0.496	0.345	-0.091	-0.045	0.113	-0.072
Security	0.734	-0.015	0.460	-0.208	-0.021	-0.057	-0.105
Instructions and signs	0.738	-0.292	0.345	0.085	0.056	0.231	-0.268
Car parking	0.332	0.061	0.705	-0.242	-0.224	-0.041	-0.224
Bicycle parking	0.597	-0.147	0.615	-0.112	0.271	-0.061	0.031
Environmental sanitation	0.383	-0.514	0.560	0.178	0.058	-0.090	-0.316
Maintenance of green areas	0.615	-0.385	0.409	0.087	0.053	0.128	-0.110
Maintenance of building appearance	0.459	-0.168	0.677	-0.222	0.006	0.195	-0.130
Pasting and graffiti	0.433	-0.032	0.520	-0.291	-0.046	0.164	-0.507
Peddlers	0.211	0.149	0.867	-0.196	-0.051	-0.003	-0.082
Maintenance of public facilities	0.288	0.031	0.817	-0.060	0.044	0.052	-0.037
Informal structures	0.238	-0.190	0.777	-0.099	0.063	0.045	-0.109
Information exchange	0.285	-0.383	0.403	0.222	0.349	0.199	-0.235
Community atmosphere	-0.223	-0.117	0.056	0.164	0.767	-0.288	0.095
Neighboring service facilities	0.259	-0.813	0.180	-0.005	0.074	-0.128	0.105
Surrounding transportation	0.247	-0.056	0.066	-0.175	-0.026	-0.759	-0.171
Surrounding building forms	-0.032	-0.395	0.166	-0.776	0.063	-0.104	-0.193
Surrounding road system	0.122	-0.881	-0.138	-0.170	0.116	-0.008	0.041
Openness to surrounding areas	0.398	-0.177	0.295	-0.616	-0.130	0.125	0.000
Grade difference of blocks	-0.056	-0.849	-0.082	-0.122	0.247	0.013	-0.038

Table 2. Factor analysis of evaluation indices

Type	Features	Property management fee (RMB/m² per month)	Sample size
1	• Old multi-story and high-density residential blocks • Dull planning and design, consisting mostly of 6-story row buildings • Lack of basic management, with significantly worse environment than surrounding residential areas • Mature communities with a pleasant living atmosphere	1.05	8
2	• Middle-density and large scale residential blocks mainly developed in the early 1990s • Satisfactory property management	1.44	5
3	• Middle-density blocks mixed with buildings of various types and ages • Unharmonious environment with intensively mixed building types and land use • Average property management quality • Big difference with surrounding residential areas	1.24	21
4	• Middle- and high-density new commercial housing blocks • High-quality planning and design • Good environmental management system	2.38	20
5	• Middle-density residential blocks mostly developed around the year 2000 • Formal property management • Good sense of community	1.95	1
6	• High-end and small-scale new blocks • Highly closed, entrance permission strictly controlled • Superior environment • Lack of community atmosphere	3.74	8

Table 3. Types of residential blocks with environmental characteristics

5. Economic values of environmental management

5.1 A hedonic approach

Many studies have focused on the economic value of residential environments, defined as the willingness of residents to pay for the improvement of their residential environments. In practice, this is often examined using a contingent valuation approach (Willis & Garrod, 1993; Tyrvainen & Vaananen, 1998) or by identifying the implicit prices of environments using a hedonic regression approach (McLeod, 1984; Tyrvainen, 1997; Geoghegan, 1997; Tyrvainen & Miettinen, 2000).

Here, a hedonic approach is adopted to examine the impact of residential environments on housing prices. By assumption, the quality of residential environments may affect the prices of houses. In a well-functioning market, this effect is fully capitalized in market prices. Utility-maximizing households will purchase houses so that their willingness to pay for a marginal increase in the residential environment equals its marginal price, i.e. its hedonic price. In equilibrium, the hedonic price can be interpreted as the willingness of a household to pay for the residential environment (Cheshire and Mills, 1999; Boardman et al., 2001).

Therefore, the marginal effect of residential environments can be obtained by regression on the market prices of housing, which implies the benefit and cost to households.

5.2 Variable of environmental management

The categorical variable of environmental management type of residential blocks shown in Table 3 was used as the indicator of environmental management. Although the factor scores of the residential blocks constitute a more straightforward indicator of environmental quality, they are constrained by property management fees. In order to maximize their utility, households will choose an equilibrium point between satisfactory environmental management and an appropriate property management fee. Because the variable of environmental management type already takes the property management fee into account, it is more suitable for the hedonic regression analysis.

5.3 Hedonic housing price model

In practice, the supply of new commercial housing is less than the demand. To avoid sample bias caused by an incomplete market, the previously-owned housing market was taken as the sample. Through Beijing Housing Information Network, a search for previously-owned housing for sale within the 63 residential blocks in May 2006 yielded 460 matches. After confirming the lowest prices and concrete conditions of each listing with real estate agencies by phone, a final sample of 279 valid items was obtained.

The data included price (provided by real estate agencies), housing size, room type, building type, direction (the direction of main rooms), building age, interior finishing level, floors, etc. Detailed information on the location and land use of the residential blocks was collected from urban real estate statistics and GIS data, including the floor-to-area ratio, green coverage ratio, household density, and the distance to the nearest subway station, school, hospital, and to the boundary of Olympic facilities (including Asian Sports Village, Olympic Green Center, and National Forest Park).

A simple linear model was established:

$$P / indoorS = a_0 + \sum_{i=1}^{m} a_i \times x_i + \varepsilon \quad (1)$$

where *P/indoorS* is the indoor size-based unit price of apartments, a_0 is a constant term, x_i (for i=1 to m) indicates the i-th attribute, a_i is the coefficient to be estimated, and ε is an error term. For the clarity of interpretation, the specification of the simple linear form was preferred and it was proven to be satisfactory compared with other forms, such as the logarithm model and semi-logarithm model. Table 4 gives the results of the stepwise regression.

To improve the model, the assumptions of independent variables were carefully studied, and some of the variables were transformed. For example, *building age* was transformed to *ln(building age)*, assuming that its effect on the unit price decreases as the buildings age. To capture the non-linear effect on the unit prices, the variables *housing size*, *building scale*, and *household density* were transformed to categorical forms. The coefficient of $1/indoorS$ reveals the costs of kitchen and toilet facilities, which are stable regardless of house size. Housing size S was transformed to discrete variables in order to identify the nonlinear effect of housing size on unit price.

Term	Estimate	Std Error	t Ratio	Prob>|t|	Interpretation
Intercept	12.423	0.662	18.77	0.000	
Building type[row-type]	-0.317	0.082	-3.89	0.000	Row-type, -0.317; tower type, +0.317
Direction{W&E-NW&S&NE&SW&SE}	-0.173	0.101	-1.71	0.089	W and E, -0.173
Direction{NW&S&NE&SW-SE}	-0.160	0.115	-1.39	0.165	NW, -0.185
Direction{NW-S&NE&SW}	-0.199	0.196	-1.01	0.312	NE, -0.205
Direction{S&NE-SW}	0.003	0.117	0.02	0.980	SE, +0.332
Direction{S-NE}	0.419	0.134	3.14	0.002	SW, +0.209
					S, +0.63
Environmental management{3&1&6-5&2&4}	-0.531	0.069	-7.66	0.000	Type {1,3,6}, -0.531
Environmental management{5&2-4}	-0.336	0.131	-2.56	0.011	Type {2, 5}, +0.195
					Type {4}, +0.867
Green coverage ratio	0.029	0.008	3.79	0.000	+1% of green space in block, +0.029
Distance to school	-1.005	0.480	-2.09	0.037	Distance from block center to nearest school +1km, -1.005
ln(building age)	-0.843	0.147	-5.72	0.000	Building age (year) increase by *e* times, -0.843
1/indoors	57.407	26.797	2.14	0.033	1/(indoor size (m^2)) +1, +57.407
S{(0,80)-[80,190)}	0.068	0.259	0.26	0.793	*S*<50, -0.311
S{(0,60)-[60&80)}	0.053	0.154	0.34	0.732	*S*∈[50-60), +0.554
S{(0,50)-[50,60)}	-0.433	0.214	-2.02	0.044	*S*∈ [60-80), +0.015
S{[80,190)-[190,220)}	0.731	0.344	2.13	0.034	*S*∈ [80-190), +0.610
					S≥190, -0.731
Distance to subway station	-0.393	0.041	-9.51	0.000	Distance from block center to nearest subway station +1km, -0.393
Distance to Olympic park	-0.747	0.080	-9.31	0.000	Distance from block center to Asian Sports Village, Olympic Green, or National Forest Park +1km, -0.747
Building scale {>300}	-1.012	0.247	-4.10	0.000	Average building scale in block >300 units, -1.012; ≤300 units, +1.012
Household density {≥120}	0.342	0.143	2.39	0.018	Household density of block ≥120 units/ha, +0.342; <120, -0.342

R^2=0.629, Adj. R^2=0.601

Table 4. Regression model on unit price* (thousand RMB/m^2)

The model in Table 4 has 12 independent variables, all being significant. They accounted for 62.9% of the total variance of housing prices. Multi-collinearity tests showed that the 12 variables had no strong correlations. Regression tests that randomly neglected different variables demonstrated that the estimates and significance levels of the remaining variables were stable. These tests implied that the estimates of Table 4 were accurate.

The coefficients of the 12 variables give the marginal *prices* of each variable. Significant structural attributes of housing price include *building type*, *direction*, and *ln(building age)*. The effects of location variables on housing prices were strong, including *distance to school*, *distance to subway station*, and *distance to Olympic park*. *green coverage ratio* had a positive effect on housing prices. In addition, the negative coefficients of *building scale* and *household density* revealed the cost of dwelling density.

An important finding is that *environmental management had* a significant effect on prices. Among the six types, type 4 was valued the highest (867 RMB/m^2 above average), followed by types 2 and 5 (both 195 RMB/m^2 above average). In contrast, the values of types 1, 3, and 6 were much lower (531 RMB/m^2 below average).

Looking at Table 3, the results can be interpreted. Blocks belonging to type 4 were developed in recent years with up-to-date concepts of environmental design and management; Types 2 and 5 were built earlier but were maintained well through good management. Blocks belonging to types 1 and 3 were unfavorable due to management deficiencies. Type 6 blocks had superior environments, but residents' willingness-to-pay was low because the property management fees were excessively high. This fact suggests that high environmental quality of residential blocks is desirable only if the management fee is reasonable.

6. Discussion of the results

6.1 Critical factors of residential environments

Table 2 reveals that the principal factors of residential environments in residential blocks are: (1) planning and design; (2) contextual fit; (3) property management; (4) conformity of urban design; (5) completeness of facilities; (6) surrounding influences; and (7) mixture of composition. Planning and design, contextual fit, and property management are the most important factors of environmental quality.

The important indices related to the planning and design of residential buildings are: Architectural style; Exterior; Ground plane design; Barrier-free design of buildings; Garden; Detail; Partitions and walls; and Instructions and signs. In a sense, these are the comprehensive planning and design concepts of modern residential blocks. In practice, these planning and design factors have often been neglected in older traditional residential blocks, leading to low environmental quality. In contrast, commercial housing developments from the late 1990s have emphasized these aspects.

Contextual fit is another important factor for judging the quality of residential environments. It reflects the problems associated with a lack of consideration of residential areas in their entirety, their non-proximity to and lack of correspondence with neighboring blocks, and a large contrast in landscapes and environmental grades. In practice, there are many newly developed residential blocks which are completely closed off from one another. Due to the need for these residential compounds to have individualized identities, the context of the area as a whole is totally neglected. At the same time, new urban poverty

areas are being formed because of the environmental deterioration of old neighborhoods. These issues must be addressed in the environmental management of urban areas.
The role of property management is important in residential blocks. Specifically, the key factors are: Regulations on incompatible land use; Management of car parking and peddlers; Maintenance of public facilities; and Control of informal buildings. Enhancing management of the above aspects will effectively improve the environments of residential compounds.

6.2 Incentives of environmental management

The marginal prices of environmental management obtained from the linear regression model revealed the benefits of environmental management. According to Table 3, the values of the same kinds of houses can differ by up to 1359 RMB/m^2 (852+507) due to differences in environmental management alone.
It is highly valuable to know that appropriate environmental management can significantly increase the economic values of existing residential blocks. Residential blocks of environmental management types 1, 3, 2, and 5 might also enjoy this benefit by improving landscape design, maintaining greenery, providing suitable facilities, and improving sanitation, parking, and security in the compounds. These kinds of improvements are highly feasible for existing residential blocks. The clarification of the benefits generates the incentives for existing areas to adopt an effective environmental management system.
The result that the values of environmental management types 1, 3, and 6 are significantly lower than the values of other types is also noteworthy. A common feature of these blocks is that their environmental qualities are quite different from the surrounding areas: Types 1 and 3 are worse than the surrounding areas, while Type 6 is much better. The regression results imply that non-conforming landscapes and environments may reduce the value of residential blocks; that is, landscape and environmental gaps have a negative external effect on urban environments. Therefore, it is necessary to promote holistic urban planning and design.

6.3 Appropriate levels of property management fees

The variable of environmental management type was used with the hedonic regression model instead of the absolute quality of environments because the latter is constrained by property management fees. This strategy was proven to be correct by the regression results. In fact, the marginal price of residential blocks of environmental management type 6, where the environmental quality is the best and the property management fee is the highest, was 507RMB/m^2 lower than the average level.
A satisfactory residential block should not only have effective environmental management; its level of property management fees should also be reasonable. As shown in Table 3, the property management fees in residential blocks with environmental management types 2, 4, and 5 (where the benefits are higher than the average level) are 1.44 RMB/m^2, 2.38 RMB/m^2, and 1.95 RMB/m^2 per month, respectively. In the current market, it appears that the preferential level of property management fees should be 1.5-2.5 RMB/m^2 per month.

7. Conclusions

This chapter has explored the critical factors in the environmental management of urban residential areas and clarified the incentives related to urban environmental management

policies. It was determined that planning and design, contextual fit, and property management are the most critical determinants of the environmental quality of residential blocks. The level of environmental management has a significant effect on housing prices, and their marginal prices have quantified the benefits brought by the improvement of environmental management.

Environmental management also involves many soft aspects which are crucial during the stages after planning and design. For existing residential areas, this point is extremely important. It suggests that it is possible to improve the values of properties by maintaining adequate levels of environmental management, thereby bringing substantial benefits to residents. In other words, environmental management provides an effective way to revitalize existing residential areas. It is therefore critically important to introduce new environmental management systems to save the older neighborhoods from dilapidation.

In the above analysis, we have also offered suggestions for promoting the contextual fit of urban areas through planning policies and guidelines for setting an appropriate standard of property management fees. Despite the fact that the study area is limited to Beijing, the main implications of this study should be applicable to many other similar urban areas, though the results of quantitative analysis may differ somewhat depending on the area.

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6

Leadership Development and Management of Environmental Non-Governmental Organizations

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1. Introduction

The Overview section depicts the emerging power and the role of the 3rd Sector in general and environmental non-governmental organizations or NGOs in particular in advancing environmental causes. A history of their coming-into-being and their evolution triggered by "Silent Spring" is introduced. Possible future role of environmental NGOs in effecting changes toward a better environment is discussed. This section sets the tune for further elaborations on how an environmental NGO may best develop its structure, leadership, programs and management scheme.

1.1 Historical background

"Non-governmental organizations" or NGOs, as we know them today are generally thought to have come into existence in then industrialized European countries and in the United States around the mid-nineteenth century (WANGO, 2008). In the United States, Founded in 1892, Sierra Club is probably the oldest NGO with an environmental focus in the States. A century or so later the importance of NGOs was officially recognized by the United Nations (UN). The term came into use in 1945 by UN to differentiate in its Charter between participation rights for intergovernmental specialized agencies and those for international private organizations (Mostashari, 2005). At the UN Congress in San Francisco in 1968, a provision was made in Article 71 of the Charter of the United Nations framework that qualified NGOs in the field of economic and social development to receive consultative status with the Economic and Social Council. At the UN, virtually all types of private bodies can be recognized as NGOs. They only have to be independent from government control, not seeking to challenge governments either as a political party or by a narrow focus on human rights, non-profit-making and non-criminal.

The non-profit-making qualifier is an important attribute of NGOs. Often they are also referred to as Non-Profit Organizations or NPOs. NGOs or NPOs are regarded as a force for good by virtually all nations in the world. As a whole, they are considered as the "Third Sector," while the government and the private sector are the 1st and the 2nd sector, respectively. Their unique role is usually recognized and defined legally in a country they operate in. For example, those who qualify and meet specific requirements stipulated by the Internal Revenue Service (IRS) of the Untied States are typically called the 501 (c) (3)

organizations. A 501 (c) (3) entity has a tax-exempt status, a privilege that allows it to dispense its financial resources to do more good to the society. Qualified activities include: Religious, Educational, Charitable, Scientific, Literacy, Testing for Public Safety, to Foster National or International Amateur Sports Competition, and Prevention of Cruelty to Children or Animals (IRS, 2008). Virtually all reputable NGOs with an environmental focus, or Environmental NGOs for short, in the United States, are registered with the U.S. government as 501 (c) (3) entities. Examples include the Natural Resources Defense Council, the Environmental Defense Fund, and the Sierra Club, just to name a few.

Recent decades have seen an increase in the number, role, and functions of environmental NGOs. The one, single most notable watershed event took place in 1962 when Rachel Carson published "Silent Spring." Her book depicted how destructive such chemicals as DDT are to the environment. Her alarm touched off a national debate in the United States. It set in motion set in motion a course of events that would resulted in the ban of domestic production of DDT in 1964 and the creation of a grass-roots movement demanding protection of the environment through state and federal regulation. Carson's writing initiated a transformation in the relationship between humans and the natural world and stirred the awakening of public environmental consciousness (Carson et al., 2002). Her inspiration triggered the sprouting of many environmental NGOs, e.g. the coming-into-being of the Environmental Defense Fund in 1967 and the Natural Resources Defense Council in 1970. These and other NGOs have become champions for the environment.

1.2 Post "Silent Spring" era: the character defining moment of the environmental NGOs

Today, environmental NGOs are playing increasingly vital roles in directly impact and influence environmental issues on the international, national, and local levels. The environment emerged as a new critical international issue in the 1970s. Concerns such as the depletion of natural resources, climate change, and harmful pollutants began to gain awareness in the public's mind. In the United States, the environmental movement emerged from incidents and individuals reacting to governments who might be slow, unable or unwilling to address issues and problems. The long and winding road toward the "Clean Air Act" typifies how the environmental movement in general and the NGOs in particular have been defined their unique character – environmental advocacy.

In 1923, leaded gasoline was introduced to the market to enhance engine performance of automobiles. Although the harmful effects of lead to health are increasingly recognized, auto makers fight mandatory emissions control for their cars. In 1967, Congress finally passed a bill called "Air Quality Bill of 1968," the first federal legislation aimed at reducing pollution. Without setting standards, imposing hard deadlines, and providing enforcement, though, it failed to accomplish its goals. It was, however, a good first step that provided a framework for more effective legislation down the pipeline.

In 1970, Senator Gaylord Nelson (D-WI, 1963-1981) found inspiration in the 1969 anti-war movement and proposed a large-scale demonstration on behalf of the environment. He organized and founded Earth Day, the first mega-scale grassroots environmental rally. On April 22, 1970 millions of participants across the country simultaneously voiced their environmental concerns. The idea was big enough to make headlines across the country in major news outlets, which report on the planned event in the preceding months. A masterpiece was the one printed on the New York Times, which reads: "Rising concern about the environmental crisis is sweeping the nation's campuses with an intensity that may

be on its way to eclipsing student discontent over the war in Vietnam ... a national day of observance of environmental problems ... is being planned for next spring ... when a nationwide environmental 'teach-in' ... coordinated from the office of Senator Gaylord Nelson is planned (Hill, 1969)." Sen. Nelson said years later, "We had neither the time nor resources to organize 20 million demonstrators and the thousands of schools and local communities that participated. That was the remarkable thing about Earth Day. It organized itself." This first-ever Earth Day event indeed expedited the 1970 Clean Air Act, the first of its kind of legislation in the world that placed concrete measures to combat air pollutions.

As 1970 drew to a close, Congress passed ground-breaking rules to curb pollution. Its principal provisions are:

1. Establishing National Ambient Air Quality Standards (NAAQS). The law requires that EPA identify and set standards for pollutants identified as harmful to human health and the environment.
2. Primary and Secondary Standards. The Clean Air Act establishes two categories of air quality standards: Primary standards set limits to protect public health. Secondary standards set limits to protect against public welfare effects, such as damage to farm crops and vegetation.
3. Leaded gasoline phase-down. The law requires leaded gas to be phased out by the mid-1980s — one of the single most important and successful environmental health initiatives of the last century.

The impact of the Clean Air Act is enormous. By 1995, the percentage of U.S. children with elevated blood-lead levels has dropped from 88.2% in the 1970s to 4.4%, according to data compiled by the Centers for Disease Control and Prevention (CDC). In fact, almost all the pollutants that contribute to the National Ambient Air Quality Standards have significantly decreased since 1970:

Carbon Monoxide: 31% decrease
Sulfur Dioxide: 27% decrease
Particulate Matter* (PM-10): 71% decrease
Lead: 98% decrease

*Particulate matter — particles in the air — include soot, smoke, dirt, and liquid droplets.

Though not one of the six criteria pollutants, volatile organic compounds, such as dry cleaning fluids and paint thinners, which contribute significantly to photochemical smog production and certain health problems, have also declined some 42% from their 1970 levels (Rowell, 2003).

It is worthwhile noting, that, since its birth in 1970, the Earth Day movement has evolved into the Earth Day Network. To date (2010), the network has a global reach with more than 20,000 partners and organizations in 190 countries. More than 1 billion people participate in Earth Day activities, making it the largest secular civic event in the world. It is a living proof that ideals and values can become "forces for good."

As the laws of physics dictate, whereas there is a force, there will be a counter-force. The environmental NGOs and the causes they are fighting for are no exceptions. When it comes to the Environment, however goodwill-intended an agenda, there is no shortage of controversies. A case in point is that, despite the huge benefits of the Clean Air Act, the counter-force has always been at work in rolling back pertinent regulations and enforcements stipulated in the Act.

Because many states fail to meet mandated targets, the first set of Clean Air Act amendments is adopted in 1977. One of the most effective of these is the New Source

Review (NSR), which addresses older facilities that had been "grandfathered" by the original law. In 1970 Congress had assumed that older industrial facilities, such as power plants and refineries, would be phased out of production, so they were exempted from the legislation. But when these big polluters continued to operate and emit pollution at much higher levels than new facilities that were built with modern pollution-control equipment, lawmakers knew they had to act. The resulting New Source Review requires older industrial facilities that want to expand to undergo an EPA assessment and install pollution control technologies if their planned expansion will produce significantly more emissions. Alternately, these facilities can opt to offset the increased emissions by lowering them in other units they own. This way, older plants will not impinge on the cleaner air more modern plants are responsible for.

On Dec. 31, exactly 32 years after President Richard Nixon signed the Clean Air Act into law, the Bush administration announced significant rollbacks to pollution control provisions. Key points include:

1. New rules allow virtually all pollution increases from old, high-polluting sources to go unregulated. EPA will allow companies to avoid updating emission controls if their plant's equipment has been reviewed at any time within the past decade, and the measures used to calculate emissions levels will be reconfigured.
2. The review process built into NSR is drastically scaled back. Until then, when facilities wanted to expand their production, thereby increasing their emissions, they would have to apply for permission and undergo EPA scrutiny and public comment. The rollback does away with this requirement. Since the new regulations went into effect in March 2003, communities will not know when a nearby power plant is increasing the amount of pollutants pumped into their backyards.

Wrestling between enforcement and rollback of an environmental law goes back and forth; and environmental NGOs certainly play a pivotal role in this type of tug-of-wars. Take Clean Air Act as an example, the Natural Resources Defense Council (NRDC) is probably one of the most reputable organizations that are willing to pick up the fight. Formed in the same year the Clean Air Act passed, NRDC has been a watchdog that diligently tracks the progress (or the lack of it) of the law's implementation since 1970.

NRDC is a membership-based organization and has the support of 1.3 million members and online activists. Internally the organization has a staff of more than 300 lawyers, scientists and policy experts. The sizable membership, supporters and the well-trained workforce enable NRDC to be a strong advocate for the environment.

As an advocacy group, the organization operates a solid legislative team that is dedicated to protecting and building upon America's framework of environmental laws. The team analyzes and keeps interested stakeholders up to date with latest legislation affecting environmental issues through its biweekly Legislative Watch Bulletin. The Bulletin tracks all environmental bills moving through Congress. Periodically, the organization publishes major issue papers based on its research and analysis effort. For example, as lately as December of 2008, it made public the issue paper titled "Repairing Health Monitoring Programs Slashed under the Bush Administration." In a straight forward manner, the paper pointed out the cutbacks by USEPA on air quality monitoring programs. It also made clear the significant back-paddling of the White House from the Act. In addition, the paper gave specific recommendations on what has to be restored in order to protect public health from air pollutions (Rotkin-Ellman et al., 2008).

The organization also maintains a viable "Climate Center" to contribute to relevant causes in combating global climate change and, in this context, in monitoring the Clean Air Act. One of its approaches is to have the ears of the US Congress. For example, in 2007, the Center proactively provided testimony to the US Senate Committee on Environment and Public Works in its public hearing on "The Implications of the Supreme Court's Decision Regarding EPA's Authorities with Respect to Greenhouse Gases under the Clean Air Act." Again, the organization deployed its viewpoints based on solid science and with specific recommendations. A portion of the excerpts highlights the eloquence of the typical NRDC style:

"…NRDC supports placing every ounce of pressure you can on the Administration to faithfully execute the existing law of the land. The actions already within EPA's power would take a big bite out of global warming. At the same time, we also support enactment of new economy-wide legislation to comprehensively address global warming.

In NRDC's view, solving global warming requires three things:

- A mandatory declining cap on national emissions that starts cutting emissions now and reduces them by 80% by 2050.
- Performance standards – for vehicles, fuels, and power plants, as well as buildings, appliances, and other equipment – to quickly deploy today's emission-cutting technology and promote rapid development of tomorrow's.
- Incentives – drawn mainly from the value of emissions allowances – to promote new technology, to protect consumers (especially low-income citizens), workers, and communities, and to help manage adaptation to climate impacts that we cannot avoid...." (Doniger, 2007)

NRDC's effort of this sort addresses not just the Clean Air Act, but also other legislations such as the Clean Water Act, the Endangered Species Act and beyond. The collective strength greatly expedites its agenda in protecting the planet's wildlife and wild places, and to ensure a safe and healthy environment for all living things.

1.3 The futures of environmental NGOs

The continuing saga of "going-back-and-forth" on the Clean Air Act shows the dynamic nature of an environmental cause: the acting/counter-acting forces are always at work. This characteristic and the way NRDC conducts advocacies may shed some light on how an environmental NGO may strive for: Be a Force of Good to achieve more impact.

For NGOs as a whole, the 1980s and early 1990s were all about replicating programs. Around the turn of the millennium, it was about building effective organizations. The next leap is to see them as catalytic agents of change; the NGOs or NPOs are to work as "Forces of Good" to achieve more impact (Crutchfield and Grant, 2008).

As Crutchfield and Grant (2008) pointed out, that, in striving to balance the counter-forces and in seeking greater impact for better societal advancement, organizations must learn how to do the following:

1. Work with government and advocate for policy change, in addition to providing services;
2. Harness market forces and see business as a powerful partner not as an enemy to be distained or ignored;
3. Create meaningful experiences for individual supporters and convert them into evangelists for the cause;

4. Build and nurture nonprofit networks, treating other groups not as a competitors for scarce resources but as allies instead;
5. Adapt to the changing environment an be as innovative and nimble as they are strategic; and
6. Share leadership, empowering others to be forces for good.

One may regard these things as the guiding principles for a NGO to consider in shaping its future to be a "great" environmental advocate.

2. Organizational structure and management of an environmental NGO

In this section, a roadmap for environmental NGO is depicted. It depicts the forming and operation of an organization, including the visioning process, strategic planning, program development and project implementation. A practical management scheme with a set of essential ingredients for environmental NGOs is highlighted. Wherever appropriate, advices for best practice are suggested.

2.1 Roadmap for an environmental NGO

One picture is better than a thousand words. Figure 1 is a roadmap that illustrates key elements on how, in a lifecycle context, an environmental NGO is conceived. The diagram also depicts the generic structure of an organization and how it operates. Conceivably, this roadmap should be applicable to most, if not all NGOs.

At the upper left corner of the diagram is the current status of the world. The world can be regarded as a glass that is half full. As such, it is likely that there is always an individual or some individuals who feel the urge to help add something into, or take something out from it. In other word, someone or some ones will always have the desire to shape the world to a future more desired state. The roadmap provides a synoptic reference on how things get done.

2.1.1 The forming of an environmental NGO

To begin the process, people of the like-mind are to come together to identify and consolidate their "shared values." A shared value can be as concrete as focusing on protecting a specific bird; or it could be as broad as improving public health. Shared value enables a group of enthusiasts to work together and to market their ideals to pertinent stakeholders and to possible donors. It helps gather momentum and resources, financial or otherwise, toward forming an NGO for the cause.

To conduct business, NGOs do not necessarily have to be registered with the government. Through registration an NGO becomes a legal entity in a jurisdiction and acts as such, e.g. signing and executing contracts. If not registered, such necessities may be done in the name of an individual for an NGO. The case in point is the first Earth Day Movement in 1970. In this instance, the initiators led by Senator Gaylord Nelson were able to mobilize millions of people for a common cause without a formal institution.

For all practical purposes, however, one might prefer to formally register his/her organization as a "legal entity." One key incentive is the tax-exempt status for a formally registered NGO. The reason is simple and explicit: As long as the funds are spent on the cause specified in the registered official documents, portions or all of the expenses may be exempt from taxation. The tax-exempt status is not just a mechanical advantage. In many

instances, it allows others, typically businesses and individuals, to make tax-deductable donations to an NGO. Furthermore, the tax-exempt status renders a psychological edge to an officially registered and recognized NGO. Normally people would regard an organization with such status as philanthropy or a charity for a good cause, and will be more passionate to support.

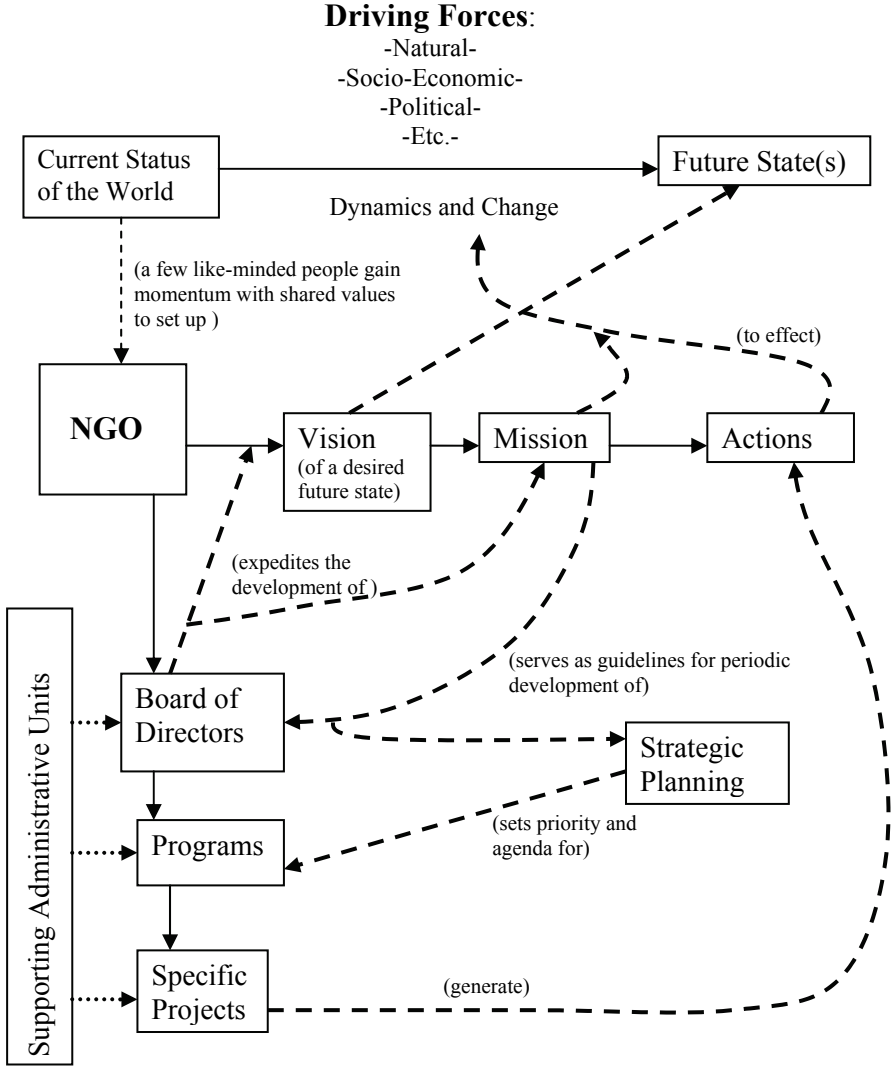

Fig. 1. Overview of an Environmental NGO's Organization Structure and Its Role in Effecting Change

To become a legal entity, an NGO would need to file certain documents as formal elements of institutionalization with the government. The formal elements of institutionalization usually include a charter of the entity to be formed, and the articles of incorporation or pertinent bylaws. These documents would contain some specificities of an NGO, including its purposes (causes), domains of engagements and activities, stipulation of regular meetings of a governing board, and quite often, a set of sunset clauses. After gaining initial legal and tax-exempt status, an NGO does need to file forms with government on how funds were dispensed on justifiable grounds to maintain such status.
The way NGOs register, gain and maintain tax-exempt status varies from country to country. However, the principles on how they are regarded as philanthropies/charities, or **Forces for Good**, by governments, business communities and stakeholders at large are basically the same.

2.1.2 The structure of an NGO

Generically, an NGO consists of four components. They are: 1) Board of Directors or Trustees; 2) Programs; 3) Specific Projects; and 4) Supporting Administrative Units.
The Board of Directors is the governance body of an NGO. It sets the policies, approves the programs and oversees their implementations. Programs are the managerial body of an NGO. They consist of domain areas an NGO target or plan to target to further its causes. Structurally, there is usually a president, an executive director or so-called CEO. He/she reports to the Board. With authorization from the Board, he/she bears overall responsibilities of the organization and the programs. For a sizable NGO, there may be a program officer for each program. The program officers report to the CEO. Projects are each a specific action that is grouped under a domain program. Usually there is a project leader or a project coordinator assigned to this specific action. It is the "field implementation" of an organization. Project leaders or coordinators report to the program officer of their domain. Administratively, there would be a number of supporting units that maintain the day-to-day operations of an NGO. The operations usually consist of office administration, fiscal management, accounting and internal auditing. Usually there is a vice president or an associate director who oversees these administrative functions. He/she reports to the CEO of the organization.
On a generic environmental NGO setting, the Board and the CEO govern; the program officers manage; the project leaders and coordinators implement or act; and the administrative support units operate.

2.2 The fundamental processes of an environmental NGO

With initial structure in place, an environmental NGO may start pertinent processes toward attaining what it was set forth to pursue. There are three fundamental or key processes an NGO needs to enact. They are 1) visioning, 2) strategic planning and 3) Actions.

2.2.1 Visioning

As the famous visioning expert Steven C. Ames once said: "If we wish to create a better world, we must first be able to envision that world." Visioning is an exercise for an individual or a group to establish proper perspectives on a subject matter of interest. It is a common practice carried out by a community, a business or an NGO. The most commonly adopted methodology is so-called "The Oregon Model" (Ames, 1993). In essence, four sequential

perspectives are to be established through the visioning process. They are: 1) Where are we now; 2) Where are we going; 3) Were do we want to be; and 4) How do we get there.

Based on the Oregon Model paradigm, it is contended that an environmental NGO may follow the four steps to expedite its visioning process:

Step 1. "Where are we now?" This step focuses on profiling the current state of an interested domain or domains of the world, e.g. air, water and/or wildlife: describing the backgrounds and important features of the domain(s), assessing their strengths and weaknesses, defining current issues and concerns, and articulating core values the organization holds dearly to itself and wish to share with of its targeted audiences, i.e. pertinent government agencies, businesses and certain sectors of the general public.

Step 2. "Where are we going?" This step focuses on determining where the domain(s) of interest is headed if current directions persist. Relevant demographic, economic, environmental and social trends are identified, and emerging issues that may impact the domain(s) are postulated. "Probable" scenarios are then developed showing what the domain(s) of interest might look like in the future if it continues on its current course with no major changes in direction.

Step 3. "Where do we want to be?" This step represents the core of the visioning process. The purpose is to articulate a vision of what the community wishes to become in the future. Starting from the probable scenario, a "preferred" scenario is developed showing what the domain(s) could look like in the future if stakeholders could be mobilized to respond to identified trends and emerging issues in a manner that is consistent with the organization's core (and shared) values. Ultimately, this "realistically idealistic" picture becomes the basis of a formal vision statement.

Step 4. "How do we get there?" In this step the organization begins planning to achieve its vision. This phase is, in essence, a self-contained strategic (or "action") planning process. It identifies short-term strategies and actions intended to move the domain(s) of interest in the direction of its long-term vision. It also identifies programs responsible for implementing specific actions, timetables for completion of these activities, "benchmarks" for monitoring progress, and other relevant information. The resulting action plan is designed to be revised and updated several times over the lifetime of the vision.

Usually the most tangible outcome of the visioning process of an environmental NGO is the creation of a mission statement. The mission statement usually consists of the values, overall issues, and goals (and sometimes objectives) an environmental NGO has conceived. It serves to guide an environmental NGO on its organizational journeys to effect change to the environment from its current condition to a desired future state. As an example, the mission statement from NRDC reads as follows:

"The Natural Resources Defense Council's purpose is to safeguard the Earth: its people, its plants and animals and the natural systems on which all life depend.

We work to restore the integrity of the elements that sustain life -- air, land and water -- and to defend endangered natural places.

We seek to establish sustainability and good stewardship of the Earth as central ethical imperatives of human society. NRDC affirms the integral place of human beings in the environment.

We strive to protect nature in ways that advance the long-term welfare of present and future generations.

We work to foster the fundamental right of all people to have a voice in decisions that affect their environment. We seek to break down the pattern of disproportionate environmental burdens borne by people of color and others who face social or economic inequities. Ultimately, NRDC strives to help create a new way of life for humankind, one that can be sustained indefinitely without fouling or depleting the resources that support all life on Earth."

The mission statement sets the foundation for the ensuing strategic planning in an environmental NGO.

2.2.2 Strategic planning

Strategic planning is the process to incorporate an organization's vision, mission, values, overall issues, and goals (and sometime objectives) into programs. Usually goals refer to what an organization strives to attain in a longer term, e.g. 5 or more years; objectives are targets of accomplishment on a shorter term, e.g. 3 to 5 years or less. Along the process, priorities and agenda are to be set to bring about or to adjust an organization's programs.

A conventional wisdom is that an organization usually repeats a visioning exercise once a decade or even once in two decades; a strategic planning is done every 3 to 5 years. However, our Environment is changing at a much faster and more alarming pace than in the past (Think about the disappearance of glaciers!). It is highly advisable that an environmental NGO considers collapsing and synchronizing the two endeavors in a same 4 to 5 year intervals. In addition, it may be preferred that the interval and timing be tuned optimally to be coinciding with the political and/or planning systems of major economies of the World. As Figure 1 shows, there are driving forces that effectuate changes of the World and the Environment. Optimal timing of visioning and strategic planning may make it more conducive for an environmental NGO to tap into and or to leverage the forces for its cause toward change for the better.

There are 7 key steps in a strategic planning process (Bryson, 1994). They are: 1) development of an initial agreement concerting the strategic planning effort (or the "plan" for planning; 2) identification of mandates; 3) clarification of mission and values; 4) assessment of the external environment; 5) assessment of the internal environment; 6) identification of strategic issues; and 7) development of strategy. And, if in sync with visioning process as is stipulated above, there would be the 8th step of preparation of a description of the organization and the domain(s) of interest in the future.

The strategic planning process sets priorities and agenda on the line-up and/or the adjustment of program areas an environmental NGO strives for in the timeline planned for. Take NRDC as an example; the organization currently has a line-up of 13 program areas. They are: Air & Energy, Center for Advocacy and Campaigns, Center for Market Innovation, Climate, Health, International, Land & Forests, Legislation, Litigation, Midwest, Nuclear, Oceans, Science Center, Urban, and Water.

2.2.3 Actions

Strategic planning results in programs. Each program serves as the launching pad for the design, planning and implementation of specific projects under a particular umbrella program. Those specific projects are where actions take place; and if executed as intended, exert impact in effecting change of the targeted domain(s) toward a better future state. It is through specific projects or actions that stakeholders gain insights to an NGO and have a

more direct feel on the impact of what that organization may exert on a particular cause. In other words, actions are the interface between an organization and its stakeholders.

Action planning is necessary to ensure that selected proposals or options dealing with the issues actually are implemented. Action plans detail the specific means by which strategies will be implemented and strategic objectives reached (Bryson, 1994). Action plans typically incorporate the following five factors:

1. The specific steps or actions required,
2. Who will be held accountable for seeing that each step or action is completed;
3. When these steps or actions are to be carried out;
4. What resources need to be allocated in order to carry them out; and
5. What feedback mechanisms are needed to monitor progress within each step (Morriessey, et. al., 1987).

In addition, it would be wise to fully comprehend the old saying of "Idea is cheap." It is particularly important that action plans be coordinated with the organizational budgeting process to make sure adequate financial resources are available to support implementation efforts (Bryson, 1994). This point is especially important to an environmental NGO. In fact, virtually all NGOs place an emphasis on identifying and locating and securing external funding opportunities. As such, NGO personnel are quite often busy in the so-called proposal development mode. The bottom line is no funding, no project, and thus no action.

2.2.4 The management of an environmental NGO

Management is perhaps the most challenging aspect of NGOs in general and environmental NGOs in particular. The reason is that practitioners of an environmental NGO are often environmental enthusiasts from board, programs down to projects. They may be full of passions. Managerial experts, they may be not. That is where administrative units come in to the picture. These units are to be filled with business professionals. They complement their environmental counterparts to enable a more comprehensive and complete management scheme for the organization. It is advisable that a comprehensive management scheme cover all aspects of an organization's operations. Derived from the framework laid out by Dees, Economy and Emerson (2001), the scheme may break down into 9 aspects:

1. Managing the mission;
2. Managing opportunities;
3. Managing resources;
4. Managing accountabilities;
5. Managing risk:
6. Managing the art of innovation;
7. Managing the stakeholders:
8. Managing the finance; and
9. Managing the social entrepreneurship of the NGO and its business planning;

For details of each managerial aspect, readers may reference the book titled "Enterprising Nonprofit" by Dees et. al.(2001). In the context of framing the issues involved, the topics related to opportunities, accountabilities and risks are briefed discussed. These topics are deemed to be of more "urgent nature" to the sustainability of an environmental NGO.

Opportunities give organizations direction, and they create or sustain social values. Good opportunities, however, are subject to all sorts of issue, including timing, changing environment, and human conditions. The ability to recognize and then pursue opportunities

is a critical skill for success in the world of nonprofit organizations (Kitzi, 2001). Key points to bear in mind are as follows:

1. Optimism is not enough;
2. Think innovation in existing services or products;
3. Recognize trends and new patterns of behavior;
4. Know that there is opportunity in chaos or catastrophe;
5. Relationships matter – makes others aware of who you are and what you are trying to accomplish – Network!
6. A great idea may or may not represent a good opportunity;
7. Assessment is an imprecise, ongoing process that includes judgmental calls and creative refinement of the idea along the way;
8. A budget is just a planning document; pursue opportunities without being limited by resources currently at hand;
9. Opportunity recognition is both a science and an art. Collect the right amount of information relevant to the size, scope, and time available. But, ultimately, gut instincts must weigh heavily in any decision-making process;
10. The amount of human and financial resources that go into answering assessment questions should depend on the level of commitment required to move forward; and
11. A clear understanding of the position of the window of opportunity is necessary before taking action because timing is everything.

NGOs or social entrepreneurs are accountable to the many stakeholders who are concerned with the common goals (Emerson, 2001a). Key points include:

1. real social entrepreneurs are not loners but work as par of a network of like-minded individuals;
2. Responsible social entrepreneurs make an effort to inform stakeholders where they are headed and how they intend to get there;
3. Accountability helps social entrepreneurs that they are achieving their goals and being responsive to their social cause and mission;
4. Consider creating a "punch list" for accountability, a framework that you can use to organize your work;
5. The destination of accountability is the journey toward being accountable!
6. Communicate your performance to your key constituencies in an understandable, timely, and accurate manner; and
7. Watch out for the road blocks to accountability.

Every organization has some amount of exposure to risk, or the possibility of an undesirable outcome. The key to risk is to understand it and then to determine how best to manage it (Emerson, 2001b). Key points to remember include:

1. Risk is the possibility of an undesired outcome;
2. Risk is measured in tow main ways: the potential magnitude of the risk and the possibility of its occurrence;
3. Personal risk tolerance is not a function of age, but a function of individuality and life; and
4. Take risk, but never gamble.

3. Leadership and its development of an environmental NGO

The section depicts a trend of the merging of leadership and management in the NGO sector. It describes styles, qualities and skills of suitable leadership. The stipulation that

"everybody is a leader" is emphasized. It also renders a comparison of various leadership models. On the premise of sharing leadership, how an NGO and its personnel may work together to expedite leadership development is suggested.

3.1 Leadership versus management

There is a well-known story about four blinded persons asked to describe an elephant. The answers, as we all know, come out to be a rope, a fire hose, a trunk and a wall. This is certainly the case when it comes to defining what leadership is.

In a conventional way, scholars of the leadership research field tend to emphasize the distinction between leadership and management. Nanus and Dobbs (1999) stipulate that leadership should never be confused with the management or administration of a nonprofit organization. The main responsibility of a manager is to operate and maintain the organization efficiently, ensuring that it provides useful services to clients or the community at the lowest possible cost. The leader, though always cognizant of current operations, is more concerned with building the organization for the future-that is, securing new resources, developing new capacities, positioning the organization to take advantage of emerging opportunities, and adapting to change.

They went on to further elaborate that Leading and managing are quite different functions. They require two separate mind-sets and two different sets of skills. Because managers are chiefly responsible for processes and operations, they are mostly interested in what needs to be done and how it can be accomplished. In contrast, the leader is concerned with strategies and direction, with where the organization should be headed and what it can and should be doing in the future. This means that the manager's attention tends to be present oriented, with one eye on costs and the other on performance. The leader cares about these things as well, but most of his attention tends to be broader and longer term, with one eye on the challenges that lie just over the horizon and the other on the growth potential of the organization (Nanus and Dobbs, 1999).

On the other hand, a new trend of thoughts is emerging that seems to blurs the line. Chait et. al. (2005) contend that there are four principles based on which a nonprofit or NGO operates. They are:

Principle One: Nonprofit managers have become leaders;
Principle Two: Trustees are acting more like managers;
Principle Three: There are three modes of governance, all created equal; and
Principle Four: Three modes are better than two or one.

Of particular interest is that the posit that there are three modes of governance that compromise governance as leadership:

Type I – the fiduciary mode, where boards are concerned primarily with the stewardship of tangible assets;
Type II – the strategic mode, where boards create a strategic partnership with management; and
Type III – the generative mode, where board provides a less recognized but critical source for the organization.

When trustees work well in all three of these modes, the board achieves governance as leadership (Chait et. al., 2005).

The above suggestion is consistent with stipulations from Sohmen (2002). Increasingly, in our resource-constrained world, nonprofit enterprises are blessed with volunteers and modestly paid employees, many of them temporary. In such a milieu, the preferred method

of operating appears to be that of organizing by projects. Launching such projects has become a response to both strategic and operational problems (Sohmen, 2002).
On a similar basis, Crutchfield and Grant (2008) point out the necessity to share leadership in a nonprofit. One of their key findings is that the average tenure of CEO for nonprofit sector is 4 years. That is a relatively short turnover rate. They stress the importance of succession planning to enable an organization to sustain its impact as an agent for change.
The above stipulations may support the contention that everybody counts in an environmental NGO and that he/she can be, should be and is a leader.

3.2 The shape of things to come with leadership

On the premise that everybody is a leader, the question then is: what is the desired leadership? Researches on this topic are abundant. Three well-known models are: transformational leadership, visionary leadership and servant leadership (Sohmen, 2002). In his work, Sohmen summarizes the comparison of the three models (see Table 1).

Leadership Model	Distinctive Features	Common Features
Transformational	Idealized influence; Inspiring vision Intellectual stimulation; Individualized development	Visionary outlook Charisma Nonhierarchical Learning-focused Mentorship o followers Empowering of people Fostering new leaders Fairness and democracy Long-term, strategic view Focus on obtaining superior results
Visionary	Inspiring vision; Competence building Trust building; Integrity in relationships	
Servant	Grassroots democracy; Leader as servant first Spirituality- and ethics- base; Balance of power and responsibility	

Table 1. Comparison of the transformational, visionary and servant leadership models

Based on the synopses, Sohmen (2002) has proposed a Nonprofit Project Leadership Model. Essential factors of the model are as follows:

1. The leader is at the center of a flat, networked and complex project organization;
2. The style of the leader is visionary, charismatic, service-oriented and nurturing;
3. The leader models deep respect for, and appreciation of, people of all cultures and skills;
4. Being competent and knowledgeable, the leader stimulate others and is a constant learner;
5. The leader plays a pivotal role in operating the nonprofit parent's strategy;
6. The leader is a skilled communicator, negotiator, and conflict manager;
7. The leader mentors followers and encourage them to interact creatively with each other;
8. The leader initiates and nurtures profound connectivity with followers and stakeholders;
9. The leader inspires trust and respect among followers by exhibiting behavior integrity; and
10. The leader selflessly concerts followers into leaders, keeping the long-term in view.

It goes without saying that characterization of leadership will continue to change as the World turns. The constant change is a reminder to an organization that continuous renewal and update of the leadership concepts and practices is a must for one to sustain.

3.3 Leadership development

The subject of leadership has been studied in depth, and there is broad agreement on several factors affecting the development of leaders (Knauft et.al., 1991). They are:

1. Leaders are not born; they are made.
2. Certain skills that are helpful to leaders, such as effective oral and written communication, can be acquired through training.
3. Workshops led by skilled trainers can sharpen people's perceptions of themselves and give insights into how they are perceived by others. But courses cannot teach essential leadership characteristics such as vision, character, or maturity.
4. Many leaders have "invented themselves" through own self-development.

In the context of running an organization, there are two aspects to facilitate leadership development: the organizational empowerment and the individual's self-development.

On the organizational aspect, Pichot (1996) proposes three models to empowering many leaders: 1) delegation within a traditional hierarchy; 2) creating a community; and 3) liberating the spirit of enterprise. The model most relevant to environmental NGOs is the Community Model.

Many great corporate leaders see their organization as communities. They create space for more leaders with inspiring goals and trust that employees guided by community spirit will generally use their freedom to do good rather than harm. If people feel part of the corporate community, if they feel safe and cared for, if they are passionate about the mission and values and believe that others are living by them, they will generally give good service to the whole. And, if they are dedicated members of the community, it will be safer to trust them to create their own leadership role across the organizational boundaries. Effective leaders use the tools of community building to create an environment in which many leaders can emerge (Pichot, 1996).

In essence, a community-oriented organization provides a conducive environment for its people to growth their leadership qualities. It is a win-win proposition.

On the personal side, there are a number of ways for self-development. Knauft et.al. (1991) suggest a Self-Analysis approach. This method is rather simple. One is to develop a set of checklist questions against fundamental traits associated with quality leadership. The 6 traits are: 1) presence of a guiding vision; 2) conveying the vision to others; 3) knowing oneself; 4) standing by one's conviction; 5) taking risks; and 6) mastering the organization.

As an example, the checklist questions for self-analysis on "Mastering the Organization" are as follows:

1. What are examples of how you change your organization to help it better achieve its mission and adapt to your vision of its potential?
2. How do you differentiate between change for its own sake and a constructive change in the status quo?
3. Once changes are made, how do you maintain the new environment and how do you respond to staff members who resist change?
4. If you move on to a new job in another organization, how would you go about analyzing its culture and, it appropriate, changing it?

The complete set of the self-analysis can be found in Knauft et.al. (1991).

Indeed, developing nonprofit leaders who embody the leadership qualities will require that individuals set their own goals and evaluate their own success (Arsenault, 2002). It will requires that individuals to become agents of their own development (Pedler & Boydell, 1980). McCall (1998) adds that individuals should have personalized development plans in order to know where they are.

Arsenault (2002) contends that such a plan should consists of four ability levels, with the bottom two focusing on individual competencies (knowing oneself) and interpersonal skills (coaching). However, the complexity of the new leadership also requires that leadership development go beyond just the individual level. Conger and Benjamin (1999) add two more development levels: socialization, which is instilling the values and visions of the organizational culture, and developing capabilities of implementing strategic change, both critical components of nonprofit leadership.

4. Integrated efficacy assessment of an environmental NGO

Efficacy is the bottom line for an environmental NGO. This section introduces a simple yet powerful methodology called Holistic Efficacy Assessment Routine (HEAR) in assisting an NGO assessment process. HEAR enables the processing of information from heterogeneous types and sources of data pertaining to factors deemed relevant to efficacy. A unique feature of HEAR is that it is capable of take in factors that are either qualitative or quantitative in nature, or that have either positive or negative contributions to the overall assessment. The end-product is an integrated, uniformed and normalized score bounded within the range of (-1, +1). Built in HEAR is a companion favorability scheme that maps the qualitative and quantitative scales between "absolutely-unfavorable" to "absolutely-favorable" and (-1, +1), correspondingly. The assessment score can thus be easily referenced to the favorability scheme to identify what the final result should be.

4.1 The basics of HEAR

The HEAR methodology was originally designed and developed for use by the USDA Forest Service as a decision support aid to its forest resource management (Loh, 1994; Loh et al., 1998). Later it was applied in a Ph.D. dissertation research on urban planning and development (Cleboski, 2006).

There are two key components to HEAR. They are: 1) a favorability scheme that maps the qualitative and quantitative scales between "absolutely-unfavorable" to "absolutely-favorable" and (-1, +1), correspondingly (see Figure 2); and 2) a set of equations that operates on numbers in the range of (-1, +1). This set of equations is derived from EMYCIN as part of an expert algorithm (Buchannan, 1983).

Main steps of HEAR are as follows:

1. Convert and normalize data

Data comes from various sources and exists in a variety of forms. Some may be categorical and others may be numeric. They are oranges and apples. The trick to bring them together is to convert and normalize all pertinent data into normalized and uniformed information in the range of (-1, +1).

$$Score = \begin{cases} I_A + I_B - (I_A \times I_B) & I_A > 0 \quad I_B > 0 \quad (1) \\ I_A + I_B + (I_A \times I_B) & I_A < 0 \quad I_B < 0 \quad (2) \\ \dfrac{I_A + I_B}{1 - \min[|I_A|, |I_B|]} & Otherwise \quad (3) \end{cases}$$

As an example, say, one wants to use the amount of grants a program or grant officer is administering a year as a measurement of the efficacy of an NGO. Let us assume that from some statistics one has learned that the amount range between $4 millions and $5K. If one deems the maximum can be assigned "+1" and the minimum is "0," then the mean would be (4,000,000 + 5,000) / 2 = 2,002,500. $2,002,500 can be regarded as " +0.5." This happens to correspond to "Moderately Favorable" on the mapping scheme.

The following formula can be used to calculate and convert the amount of dollars into a uniformed scheme between the two extremes:

$$\text{If } v > \text{mean, then } f(v) = 0.5 + 0.5^* (v - \text{mean})/(y - \text{mean}) \quad (4)$$

$$\text{If } v <= \text{mean, then } f(v) = 0.5 + 0.5^* (v - \text{mean})/(\text{mean} - x) \quad (5)$$

Where v is the amount of the grant officer administers; x is the lower limit; y is the upper limit; and f(v) is the normalized value between +1 and 0.

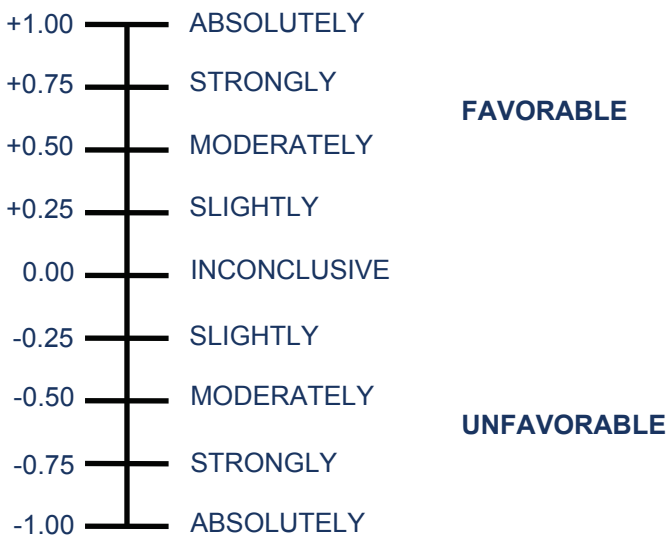

Fig. 2. The Qualitative-Quantitative Favorability Mapping Scheme

On the other hand, there may be categorical information to be considered also. Typically people cognitively tend to think qualitatively, e.g. strongly in favor or moderately negative in their opinions on a subject matter of interest. For example, the CEO may have a slightly negative opinion against a grant officer. In reference to the mapping scheme, this opinion could plausibly be interpreted to be a score of "-0.25."

The above two examples are trivial illustrations on how apples and oranges can be brought together. More sophisticated methods are possible to handle virtually any types of heterogeneous circumstances.

2. Combine information

After apples and oranges are brought together, the partial evidences can be combined. The set of equations derived from EMYCIN comes handy.

Assuming the grant officer scores a +0.5 from the funds he/she is able to bring into the responsible program and the CEO's personal opinion is -0.25, then applying the EMYCIN-derived algorithm, the accumulative score from the above two sources in Step 1 is resulted. In this case, Equation (3) is applied and the result is 0.33.

3. Repeat the information-combing process

In an assessment situation, there are probably N factors under consideration. Upon conversion and normalization, information from each factor can be combined in the pair-wise manner illustrated in Step 2 iteratively till all inputs are exhausted. Assuming the NGO conducted a client/stakeholder poll on the level of satisfaction to this hypothetical program. From Step 1, the poll gives a score of +0.4, which corresponds to somewhere between moderately-favorable and slightly-favorable. This time the two operands for information combining are 0.33 from previous step and 0.4. Applying Equation (1), the result becomes roughly 0.6.

4. Translate the final score back to qualitative information

Upon exhausting all considerations, the final score may be converted back to qualitative information by mapping with the qualitative-quantitative scheme. This step is usually needed for easier comprehension of the assessment result. In the current example, 0.6 can be interpreted as "better than moderately favorable."

4.2 Application considerations

The HEAR methodology has potential for a broad range of applications. One of which is for poll/survey. Often an NGO conducts survey to learn from its stakeholders on its programs. A popular form of questionnaires simply asks "Yes" or "No." A common practice in analyzing the results is to tally them up. HEAR may provide additional insights to what the invaluable data says.

Say you are running a service program for an NGO. You do not know how the intended beneficiaries perceive whether your program is good or not. Therefore you sent a set of questionnaires for their opinions. Table 2 is the responses to you have received:

Question	Total Number of Responses	Number of Respondents Saying "Yes"	Number of Respondents Saying "No"	Number of Respondents Leaving It Blank
Q1	31	22	6	3
Q2	31	24	4	3
Q3	31	12	19	0

Table 2. Hypothetical stakeholder responses to a survey conducted by an NGO

To apply HEAR, you may want to do two things: 1) Calculating range and 2) Converting and normalizing responses:

1. Calculating range

The reason for determining range is that often there may be non-responses to the questions; and for each question, the number of non-responses may vary. You may want to have your data truly reflecting the opinions, and range is a plausible measure.

In the cases of Q1 and Q2, there are 3 respondents leaving the answer blank to each question. You may elaborate that some people do not think those questions are important. These opinions evidently should be considered. If this elaboration holds, then the range should be proportionate to those non-responses.

$$R = \frac{\text{(Total Number of Responses – Number of Non-responses)}}{\text{Total Number of Responses}} \quad (6)$$

From data shown in Table 3, both Q1 and Q2 have R = (31-3)/31 = 0.903226. It means that whatever the ensuing normalized number from Q1 or Q2 may be, it should multiply this R of 0.903226. On the other hand, the ensuing normalized number from Q3 should be as it is from whatever formula you use to arrive at, since the R equals 1.

2. Converting and normalizing responses

Now we are in business to make conversions of raw survey data. Assume that more positive responses mean respondents are "more favorable" to an aspect of the service program in question and vice versa in a linear correspondence, then we can apply the following equation:

$$I_n = (X - \text{Mean})/\text{Mean}*R \quad (7)$$

where I_n is the weight (the score) from Question N; X is the number of "Yes" and Mean is the average (e.g. 31/2 = 15.5).

Let us plug Equation (7) with various "made-up" data of number of "Yes" and see how they "behave" for either Q1 or Q2 (Table 3). For Q3, the score is the one in the 3rd column. It just so happens that the above tabular conversion is applicable to both Q1 and Q2, since both have 3 non-responses. In the case of Q1, the converted score from "24" to the corresponding normalized index of I_1 is 0.495317. For Q2, I_2 (22 answered Yes) should be 0.378772. By the same token, I_3 for Q3 data (12 answered Yes) should be -0.22581, which rightfully is in the negative territory.

With all scores converted and normalized, you are now ready to apply the EMYCIN-derived formula. After two iterations, the final result turns out to be 0.595031. It should be noted that after combing I_1 and I_2, the tentative result was 0.686477. The final score is "pulled down" to 0.595031 due to the fact that I_3 is negative (-0.22581). This makes sense. In a real world decision-making or assessment situation, we most likely will face some factors that have positive contributions and others that have negative contributions. HEAR reflects what the real world is. This methodology evidently is a much improvement to many "standard" methods on combining weights that can only go up.

4.3 The HEAR advantage

The nicety of the HEAR methodology is that:

1. Regardless of however many factors are being used, you always "operate" on two of them at a time. This is called pair-wise calculation.
2. Depending on the score values of the two factors, there will be only one of the equations applicable.
3. Unlike many "ordinary" algorithms, this formula allows both positive and negative contributions from factors under considerations. This is more realistic.
4. Regardless of however many factors being considered and operated on, the resulted score will always be bounded between -1 and +1.
5. Regardless of the sequence each factor is put into pair-wise calculation, the result is always the same.
6. Once all factors are exhausted in the calculation, one can always convert the result back to the qualitative scheme to make it more comprehensive to lay persons or people one intend to interpret the results to.

No. of Yes	Score with R = (Total No. of Responses – Number of Non-responses) / Total No. of Responses	Score with R = 1
31	0.903226	1
30	0.844953	0.935484
29	0.786681	0.870968
28	0.728408	0.806452
27	0.670135	0.741935
26	0.611863	0.677419
25	0.55359	0.612903
24	0.495317	0.548387
23	0.437045	0.483871
22	0.378772	0.419355
21	0.320499	0.354839
20	0.262227	0.290323
19	0.203954	0.225806
18	0.145682	0.16129
17	0.087409	0.096774
16	0.029136	0.032258
15	-0.02914	-0.03226
14	-0.08741	-0.09677
13	-0.14568	-0.16129
12	-0.20395	-0.22581
11	-0.26223	-0.29032
10	-0.3205	-0.35484
9	-0.37877	-0.41935
8	-0.43704	-0.48387
7	-0.49532	-0.54839
6	-0.55359	-0.6129
5	-0.61186	-0.67742
4	-0.67014	-0.74194
3	-0.72841	-0.80645
2	-0.78668	-0.87097
1	-0.84495	-0.93548
0	-0.90323	-1

Table 3. Linear conversion and normalization of the hypothetical survey data

Last but not least, HEAR works on whatever is currently available for assessment. As new information emerges, it can be combined with the existing result on the flight. In other words, HEAR can work on incomplete information. It renders convenience and an additional advantage for an NGO on its efficacy assessment.

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7

Management of the Salt Cake Generated at Secondary Aluminium Melting Plants

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1. Introduction

Aluminium is, due to its properties, the second most used metal after iron. It is used in a wide number of products and sectors, either alone or as an alloy (Kammer, 1999).

The aluminium production is based on an electrolytic process, the Hall-Hérolt process, in which metallic aluminium is obtained from the reduction of aluminium oxide. The metal obtained with this process is called primary aluminium. Aluminium oxide is extracted from natural bauxite in the Bayer process. Since the development of the large-scale production of aluminium oxide, aluminium production has expanded enormously (http://www.worldaluminium. org). It is worth mentioning the important growth in aluminium production in China in recent years, over 12,964 tones of aluminium were produced in 2009 (http://www.world-aluminium.org).

The recycling of aluminium is very important, since the residues of this metal can be reused without any loss of quality. The metal obtained in this way is called secondary aluminium. The aluminium destined for recycling can be divided into two categories: preconsumer byproducts from the production of primary aluminium, and scrap, associated with postconsumer aluminium. By means of melting, in some cases with prior processing, the byproducts and scrap are transformed into ingots, half balls and plates for subsequent commercialization.

Comparing primary and secondary aluminium production, the secondary process causes less environmental impact than the primary process (Drossel et al, 2003). It consumes 17 times less energy; it emits 17 times less pollution to the atmosphere; it generates between five and nine times less solid wastes, and it consumes 35 times less water. For both processes, the greatest problems derive from the generation and management of wastes.

Regarding waste generation, one of the major products of the alkaline extraction of aluminium oxide from bauxite in the Bayer process is red mud. This waste consists of iron, aluminium, silicon, and titanium, with oxides of zinc, phosphorous, nickel, and vanadium in smaller quantities (http://www.world-aluminium.org). The management of this waste is normally carried out by means of controlled landfill disposal. Recently, several studies have been published considering various applications for this type of waste (Altundogan et al., 2002; Cengeloglu et al., 2006; Sushil & Batra, 2008). During the secondary recycling of

aluminium, various types of wastes may also be generated. The most important one, in terms of the amount generated, is the named as salt cake (Sreenivasarao et al., 1997), catalogued as hazardous waste (Order MMA/304/2002, BOE 43/2002). It is generated when salt fluxes are used to improve the aluminium recovery. The composition of salt cake is metallic aluminium, several oxides (fraction named as non-metallic products, NMP), flux brines and others components in smaller proportions (Drossel et al., 2003). Based in its composition, salt cake is an important by-product of considerable economic value that is recovering, as long as the process can be economically viable.

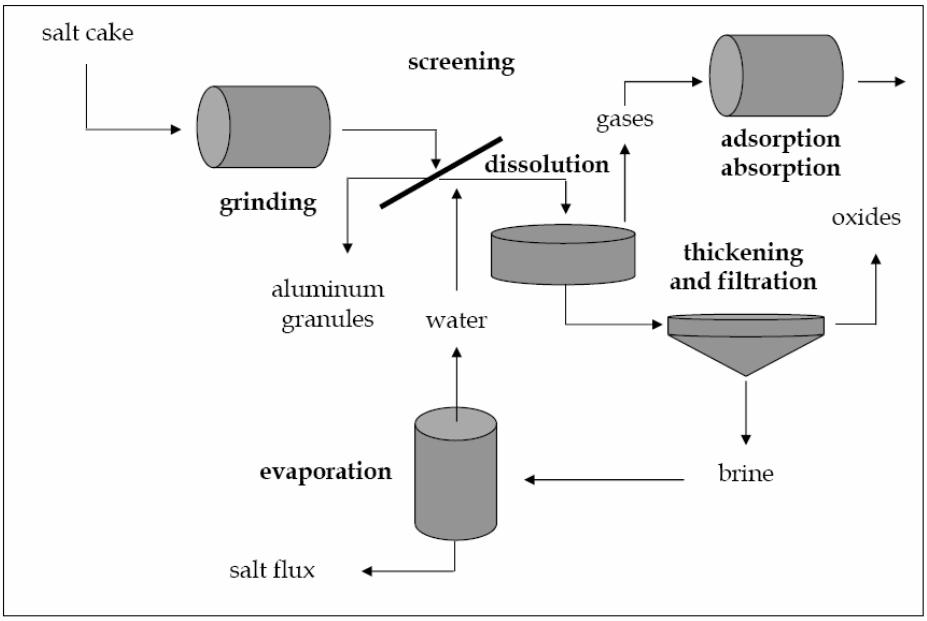
There are two possibilities of management of salt cake, separation of its components for possible recovery and application, or storage in controlled landfills (see schemes 1 and 2). The recovery process consists of an initial separation of the metallic aluminium present in salt cake by means of electromagnetic and mechanical procedures (Hryn et al., 1995). This process is economically viable if the content in metallic aluminium is higher than 4 to 6 wt.%. The remaining waste consists of non-metallic products, and it can be recovered, i.e., by the HANSE process (Drossel et al., 2003). The idea is that the saline fraction must be separated from the oxides. For certain specific applications, the non-metallic fraction should be free of salts. It is considered free of salts when the salt content is lower than 2 wt.%. It should be noted that the recovery of the saline fraction and of non-metallic products is economically viable only if a concentrated flow of salt and a waste that is free of nonmetallic products can be obtained. The main objection, in the case of subsequent applications, is that these two determining factors cannot be ensured simultaneously, meaning that the process is not economically viable.

We report in this work the process carried out by the company *Ibérica de Aleaciones Ligeras, Ltd., IDALSA*, a Spanish refinery devoted to the production of special alloys of aluminium coming from the recycling of by-products of this metal, which can be presented as a good case study of best practice. This company has implemented new several technologies in order to minimize the salt cake generation from secondary aluminium fusion process (Gil, 2005). The incorporated treatments have helped *IDALSA* to decrease the salt cake generated per each recycled ton of by-product to less than a half. Finally, the remaining waste is disposed in a controlled landfill (Gil, 2007).

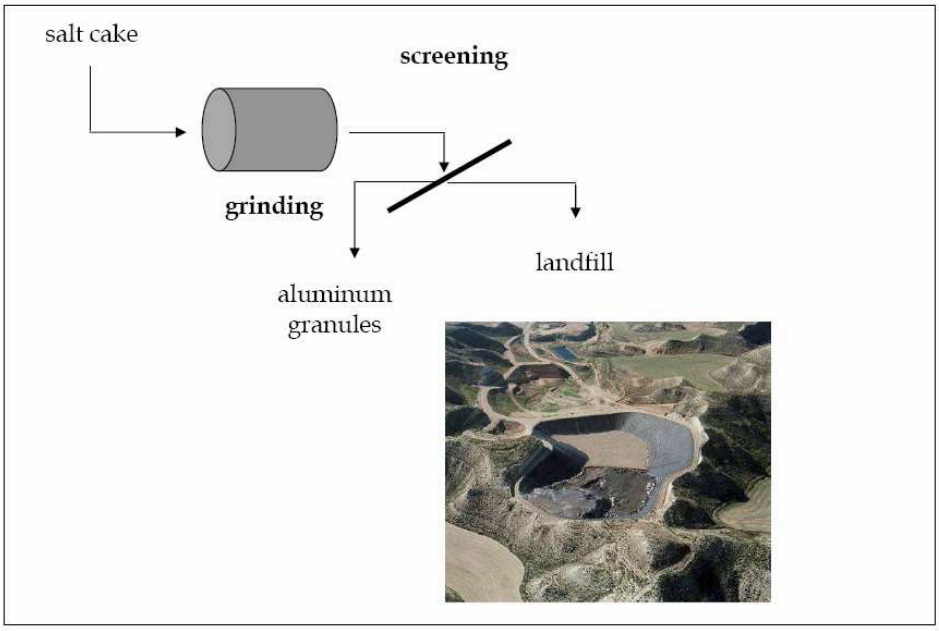
2. A case study of best practice in the recycling and reassessment of salt cake generated in the second melting of aluminium: *Ibérica de Aleaciones Ligeras, Ltd., IDALSA*

Ibérica de Aleaciones Ligeras, Ltd., IDALSA, is a Spanish company located at Pradilla de Ebro, Zaragoza (see Figure 1, http://www.idalsa.com). It has more than 25 years of experience in the production of special aluminium alloys obtained from the recycling of by-products of this metal. It recycles 6,365 Tm of aluminium scrap and by-products monthly, obtaining various formats (See Figures 2 and 3).

The model followed by IDALSA is in compliance with European Union legislation in waste Management (Directive 96/61/CE, Law 16/2002, BOE 157/2002). First, processes that involve a reduction in the generation of wastes at the origin are promoted, processes also called Better Available Technologies (Farrell, 2001). When the waste has already been produced, its recovery, recycling, and reuse should be fostered.



Scheme 1. Management of salt cake from separation of its components for recovery and application.



Scheme 2. Management of salt cake for storage in controlled landfills.

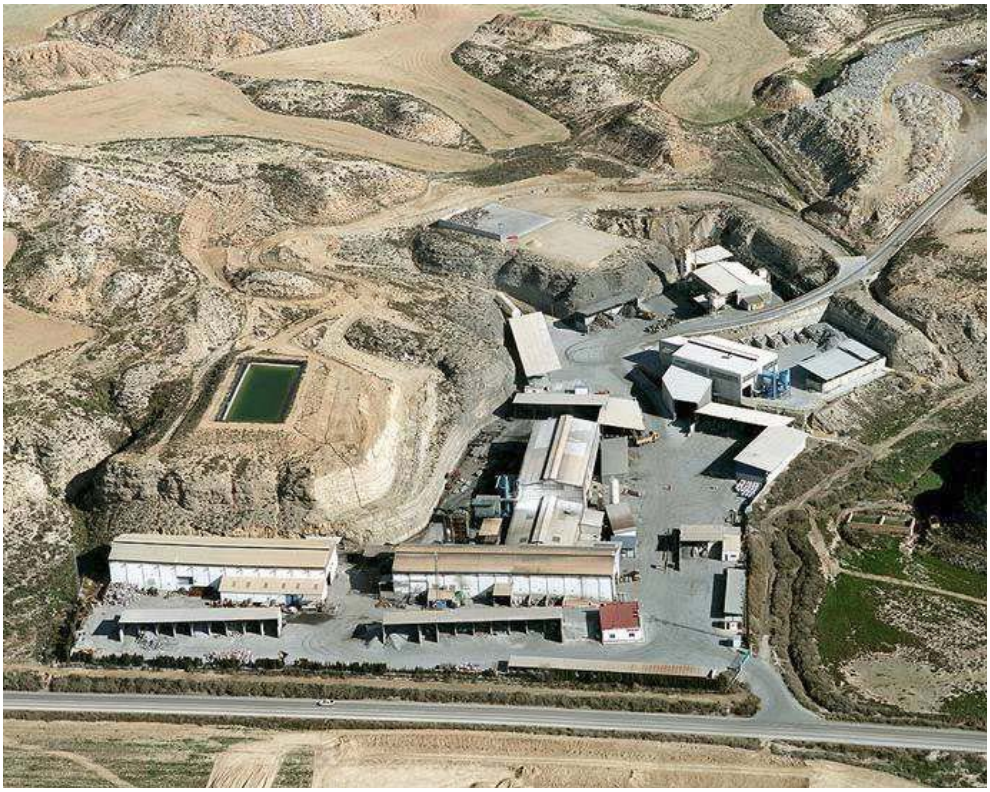


Fig. 1. Localization of *Ibérica de Aleaciones Ligeras, LTD, IDALSA*.

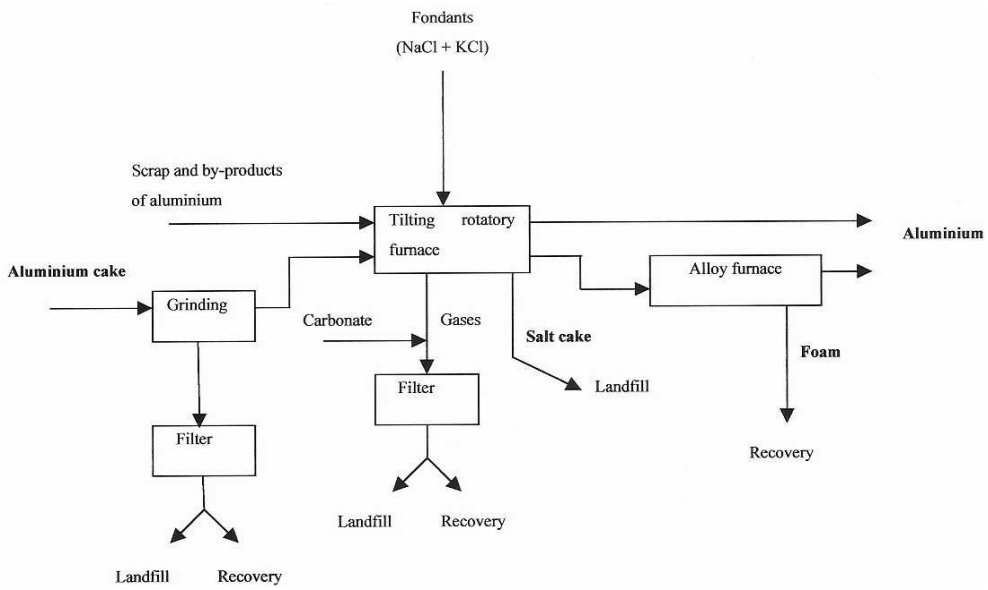
The technological measures adopted by IDALSA in its production process are as follows: oxy-combustion technology, pre-treatment of raw materials, use of a tilting rotatory furnace with a capacity of 18 Tm, and processing of salt cake. The use of a tilting rotatory furnace allows the consumption of fondants and the generation of salt cake can be minimized (Gil, 2005). The metals in the salt cake are separated by means of electromagnetic and mechanical processing of the saline and non-metallic fractions. The production processes carried out at IDALSA are schematically summarized in scheme 3.

The clean technologies considered by IDALSA have enabled reductions to be made in the quantity of waste generated by each Tm recycled to less than a half (see Figure 4), in according with a decrease in the consumption of materials and energy, and a decrease in the amount of wastes generated at the origin (Directive 96/61/CE, Law 16/2002, BOE 157/2002).

Because the management of the waste finally generated is not economically viable, IDALSA removes this through controlled landfill disposal (see scheme 1). With this target, the company has built an authorized landfill of a capacity of 100,000 m^3, at which some of its wastes can be accumulated.

Fig. 2. Examples of aluminium scraps and by-products recycled by *IDALSA*.

Fig. 3. Several formats for the commercialization of recycled aluminium.



Scheme 3. Production processes carried out at IDALSA.

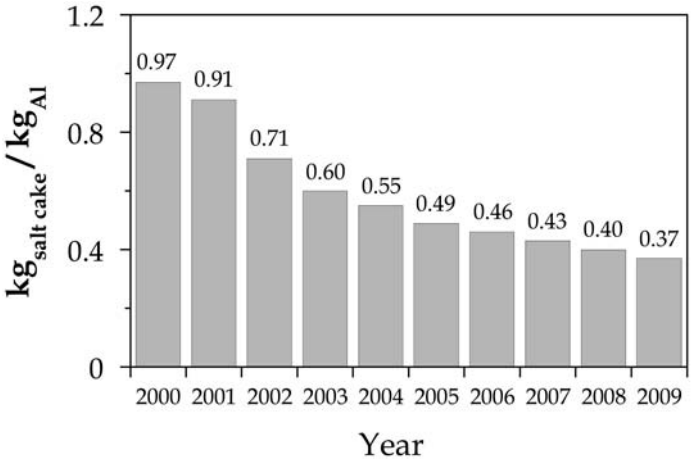


Fig. 4. Evolution of the salt cake generated with respect to the aluminium recovery obtained.

2.1 Nature of the wastes generated by *IDALSA*

The wastes generated by IDALSA in its production process are:

- salt cake from the tilting rotatory furnace. The main waste produced at the installation.
- salt cake from the rotatory furnace. This waste show similar origin and composition that the obtained in the tilting rotatory furnace.
- dust retained in the removal of gases from the furnaces.
- dust from the processing of external salt cake as a raw material.

The chemical compositions of all these wastes are shown in Table 1.

	Salt cake from rotary furnace	Dust from gases depuration	Dust from the processing of external salt cakes
Al_2O_3	29.60	33.50	70.90
NaCl	49.50	23.40	3.45
KCl	10.40	--	--
SiO_2	2.75	7.00	9.95
Na_2O	2.35	3.78	--
MgO	1.90	6.10	4.65
CaO	1.43	6.95	3.36
Fe_2O_3	1.37	2.50	5.63
N	0.40	2.60	0.10
SO_3	< 0.10	3.25	0.23

Table 1. Chemical composition (%) of the wastes from the production process of *IDALSA*.

Spanish Royal Decree 1481/2001 regulates the management of wastes through landfill disposal and specifies that the wastes destined for disposal in landfills should not be liquid, explosive, corrosive, oxidant, or inflammable. That is the case of the wastes generated at *IDALSA* (Gil, 2007).

2.3 Construction phases of the landfill and characteristics of the location

The construction of hazardous wastes landfills requires measurements of high-security that apart from the construction and exploitation of the site must also consider its closure at the end of its useful life (Royal Decree 1481/2001, BOE 25/2002). The successive phases in the construction of the landfill of *IDALSA* across a surface area of 13.5 Ha were (Gil, 2007):

- conditioning of the land
- waterproofing the landfill
- cover system
- leachate pond
- drainage system

2.4 Study of the environmental impact of the controlled waste landfill

The starting point in such assessments should be the identification of activities that may be harmful to the environment. This identification was an important element in the construction, the exploitation, and closure of the landfill. The actions related to the landfill that might lead to an impact on the environment are as follows:

- in the construction phase: this would be a result of the preparation of the lands where the landfill was located, the construction of the void volume, the alteration of the natural drainage system, and the construction of vehicle accesses.
- in the operation phase: the result of storage, transport, and covering of the wastes.
- in the sealing and closure phase: the physical presence of the landfill.

The environmental components that may be affected are as follows:

- the natural environment: the vegetation and fauna, the geology, water courses, landscape and atmosphere.
- the socioeconomic sector: land use, buildings, and other places of interest.

2.5 Criteria for impact appraisal

The attributes with which the importance of the impacts is established are those established in Royal Decree 1302/1986, and are as follows:

- sign: (+) for a beneficial character and (-) for a damaging character.
- intensity: this refers to how the environment is affected. Between 1 and 4.
- extent: this refers to the area of influence exerted by an impact. Between 1 to 8.
- time: this refers to the time between the appearance of the activity and the beginning of the effect on the factor considered. Between 1 to 4, but as a function of the time.
- persistence: this refers to the period of recovery of initial conditions, either naturally or through the introduction of corrective measures. Between 1 to 4, but as a function of the time.
- reversibility: this refers to the recovery of initial conditions once the action has stopped acting on the environment. Between 1 to 4, but as a function of the time.
- recoverability: this refers to the possibility of a return to initial conditions through the introduction of corrective measures. Between 1 to 8.
- synergy: this occurs when the consequences of two or more effects taking place simultaneously are greater than those observed if each of them had taken place independently. Between 1 to 4.
- accumulation: this refers to the progressive increase in the demonstration of an effect, when it persists in a continued form or when the action that generates it is repeated. Between 1 to 4.
- cause/effect relationship: this refers to whether the action and the appearance of the corresponding effect are related directly or not. Between 1 to 4.
- periodicity: this refers to the repeated demonstration of an effect. Between 1 to 4.
- importance: this refers to the degree of intensity of the alteration produced. This criterion characterizes the environmental impact and is determined as a function of the value adopted by each of the criteria mentioned previously.

Importance = ± (3.intensity + 2.extent + time + persistence + reversibility + recoverability + synergy + accumulation + causality + periodicity)

From the equation, the environmental impact can achieve values between 13 and 84.

2.6 Appraisal of impacts

The values calculated for the impacts identified are summarized in Table 2.

	Importance of the impact
Impact on the vegetation and fauna	40
Impact on the geology	36
Impact on the water courses	53
Impact on the landscape	33
Impact on the atmosphere	27
Impact on the land use	32
Impact on the socioeconomic context	25

Table 2. Importance of the environmental impacts of the controlled waste landfill.

The result of this quantitative evaluation is that the environmental impact of the *IDALSA* controlled hazardous wastes landfill must be considered as compatible-moderate (Royal Decree 1302/1986).

The study was completed with an analysis of emissions in the surroundings of the landfill with a view to checking air quality. The quantities of ammonia, aluminium, and particles in suspension were also analyzed. The results obtained do not surpass the maximum limits permitted by current legislation.

3. Conclusions

This work has presented a short summary of the management of hazardous waste generated in the production of secondary aluminium. The production of this waste must be minimized, it should be recycled, either wholly or partially and, if some fraction still remains, it should be disposed in a controlled landfill.

In this context, *Ibérica de Aleaciones Ligeras, Ltd., IDALSA*, has considered in its process of aluminium recycling the best technologies available in this sector in order to minimize the generation of wastes at the origin, to recover it once it has been generated and, to store the remaining fraction in a controlled landfill. The main characteristics of the controlled landfill, in according with the current Spanish legislation that regulate the removal of wastes by disposal in landfills, have been presented.

4. Acknowledgements

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8

Water Quality Analysis of the Coastal Regions of Sundarban Mangrove Wetland, India Using Multivariate Statistical Techniques

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1. Introduction

Rivers are among the most vulnerable water bodies to pollution because of their role in carrying municipal and industrial wastes and run-offs from agricultural lands in their vast drainage basins. Detailed hydro-chemical research is needed to evaluate the different processes and mechanisms involved in polluting water (Helena et. al., 1999). Furthermore, due to temporal and spatial variations in water qualities, monitoring programs that involve a large number of physicochemical parameters and frequent water samplings at various sites are mandatory to produce reliable estimated topographies of surface water qualities (Dixon & Chiswell, 1996). The results are usually compiled into a large data matrix, which requires sophisticated data interpretations (Chapman, 1992). Water quality monitoring has one of the highest priorities in environmental protection policy (Simeonov et al., 2002). The main objective is to control and minimise the incidence of pollutant-oriented problems, and to provide water of appropriate quality to serve various environmental purposes. The quality of water is identified in terms of its physical, chemical and biological parameters (Sargaonkar & Deshpande, 2003). The particular problem in the case of water quality monitoring is the complexity associated with analysing the large number of measured variables (Saffran, 2001). Belonging to the class of a tide-dominated wetland (Selvam, 2003), the Sundarban wetland is comprised of a complex network of estuaries, tidal inlets, tidal creeks and a large number of islands. Most of the creeks act as the pathway for the to-and-from movement of tidal water and downstream flow of river systems. The present day sedimentation of the Ganga-Brahmaputra systems (with average water discharge of 970 km^3/y and average sediment discharge of 900-1200 x 106 t/y) is strongly influenced by the wet summer monsoon covering only 4 months of the year when about 80% of the Ganga discharge (300 x109 m^3/y of water and 520 x 106 t/y of sediments) is contributed to the delta (Goodbred et al., 2003). The balance between freshwater and salt water in this wetland has been suffering modifications from the tilting of the G-B delta toward the east and rising sea level. Increased anthropogenic influences like withdrawal of river water from the upstream region and increase in organic and inorganic pollutants have further led to deterioration of health of the wetland (Bhattacharya, 2008).

2. Area investigated

The Indian Sundarban (21^0 32′ to 22^0 40′ N and 88^0 85′ N to 89^0 00′ E), the largest delta in the estuarine phase of the river Ganges, is a unique bioclimatic zone surrounded by the more typical geographical conditions exemplified by the coastal region of the Bay of Bengal. Situated in the low lying, meso-macrotidal, humid and tropical belt, the Sundarban harbors the World's largest mangrove forest together with associated flora and fauna. The total estuarine phase of the Indian Sundarban is very irregular and criss-crossed by several tributary rivers, creeks and waterways. There are also many other tributaries rivers like Matla, Gosaba, Muriganga, Saptamukhi etc. Seven sampling sites namely Lot 8 (S_1), Chemagari (S_2), Lower long sand (S_3), Jambu Island (S_4), Gosaba (S_5), Canning (S_6) and Dhamakhali (S_7) have been selected covering both eastern and western flank of Sunderban (as shown in Figure 1). They are of diverse environmental stresses and of different hydrodynamic conditions in the context of depth, tidal amplitude and wave action gradually being less towards the upstream direction. Among all the stations S_3 and S_4 are situated at the most seaward part of the estuary and have direct marine influence. S_2 is a macrotidal Chemaguri creek, situated 9 Km upstream from the mouth of the estuary and S_1 is situated at the Muriganga river, bifurcating distributory channel of the Hugli river. S_5 and S_6 are situated on the Bidya and Matla rivers respectively. The wetland belongs to the tropical climate with a mild winter season between October and March, a hot humid summer season between March to June and the warm and humid monsoon season from June to October when most of the precipitation occurs (average annual rain fall ~ 1800 mm).

3. Materials and methods

Surface water samples were collected in pre-cleaned polythene bottles during high tide in forenoon hours. Winkler's titrimetric method (Strickland and Parsons, 1972) was followed for the estimation of dissolved oxygen (DO) and biological oxygen demand (BOD_5). Temperature was measured onboard using a mercury thermometer (0 – 100^0C) and transparency (cm) of the water was determined using a secchi disc. pH and turbidity (nephelometric turbidity unit, NTU) were measured by a Deluxe Digital pH Meter (Model No. 101 E) and a Turbidity meter respectively. The dissolved micro-nutrients such as nitrate, phosphate and silicate were estimated by colorimetric methods described by Strickland and Parsons, 1972, after filtering the water through 0.45µ Millipore filter paper. Chlorophyll pigments (chlorophyll a, b and c) were analyzed by spectrometry following the standard method (Strickland & Parsons, 1972; Parsons et. al., 1984). Chemical oxygen demand (COD) was estimated adopting the method described by Parsons et. al. (1984).

4. Statistical analyses

Statistical analyses like factor analysis, clustering dendrogram, ANOVA were performed using statistical softwares, MINITAB 14 and XL-Stat. Data were transformed using the $\log_{10}(n+1)$ function to allow the less abundant variable to exert same influence on the calculation of similarities (Clarke & Warwick, 1994).

5. Results and discussions

A well - defined spatial and temporal heterogeneity in distribution of different water quality parameters was observed in the studied regions (Figure 2). Average surface water

temperature recorded during the study period was 24.63 – 27.89 ^{0}C. In all the stations Lot 8 showed highest mean temperature (27.68 ± 3.15 ^{0}C) and Dhamakhali (S_7) showed highest mean turbidity (24.85 ± 3.49 NTU) during the study period. The correlation coefficient (r) between turbidity and temperature showed a positive value (r = 0.502, P = 0.01) as turbidity is the condition resulting from suspended solids in the water, including silts, clays, industrial wastes, sewage and plankton. Such particles absorb heat in the sunlight, thus raising water temperature, which in turn lowers dissolved oxygen levels. Dissolved oxygen participates in many chemical and biological processes in marine and estuarine ambience and thus, it constitute an important parameter required for all type of biological investigations. DO concentration in the surface water ranged from 5.18 – 6.49 mg L^{-1} where two sites namely, Dhamakhali (S_7) and Lot 8 (S_1), showed minimum values for dissolved oxygen. Average dissolved oxygen values are greater than 4.0 mg L^{-1} indicating that surface waters are moderately oxygenated. High surface values of DO during monsoon months could be attributed to their addition by phytoplankton photosynthesis. The pH value denotes the buffering capacity of medium water and thus plays an important role in many chemical and biological processes. The surface water pH during present study ranged from 8.13 – 8.74 except Canning where mean surface water pH was low than all other sites 7.51 ± 0.20. The alkaline nature (pH>7), with low variations between the stations, suggests that the water mass remained well buffered throughout the study period and it indicates the presence of biodegradable organic matter in the water column. The high COD values of 101.29 and 114.8 mg L^{-1} at Lower long Sand (S_3) and Jambu Island (S_4) respectively, were encountered. High COD values in a tropical coastal wetland in Southern Mexico were also noticed by Hernandez-Romero *et. al*., 2004 associated with mangrove-enriched organic matter. During the monsoon months (July - October), nitrate level in water increases considerably which is due to land drainage and precipitation, again the lowering of nitrate can be attributed to the biological utilization of nitrate which appears to play an important role in primary production. Comparatively low values of phosphate observed in all the stations (range from 0.48 – 1.42 µgm atom L^{-1}) which might be due to the utilization by phytoplankton and other primary producers. Mean phosphate levels were observed to be maximum (1.96 µgm-atom L^{-1}) at Dhamakhali (S_7). This indicated that land based nutrients especially, from the adjacent agricultural fields near this site contributed greatly. Mathew and Pillai (1990) reported that the higher concentration of phosphate in coastal waters might be enriched by freshwater drainage. The nitrate and phosphate ratio showed more or less a similar trend in all the stations. It might be due to recycling of nutrients and utilization of secondary producers (Maruthanayagam, 1998). Mean concentration of chlorophyll a varied from 1.29 – 5.5 mg m^{-3} for all the sites and it showed the highest mean value followed by chlorophyll c and b. It has been recorded that concentration of chlorophyll b is always much less than chlorophyll a and c and this might be due to absolute dominance by diatoms in this estuarine system (Mukhopadhyay, et. al., 2006), which mainly contain chlorophyll a, c_1 and c_2 as their phytopigments (Reynolds, 2006).

6. Statistical interpretation

Factor analysis was carried out on the data set (14 variables) to compare the compositional patterns between the water samples analyzed and to identify the related factors that influence each of them. Four factors were extracted explaining more than 73 % of the total variance in the water quality data set. Eigenvalues were taken as criterion for the extraction of the principal components required for explaining the source of variances in the data set.

The Scree plot, as shown in Figure 3, has worked out to clarify the method of extraction of different factors. The factor analysis was actually performed on the correlation matrix between different parameters followed by Varimax rotation and the same has been used to examine their inter relationship. The parameter loadings for the four identified factors from the factor analysis of the data are given in Table 1. The factor 1 accounts for 41.86 % of the total variance. It is positively correlated (loading > 0.75) with salinity, transparency, dissolved oxygen and chlorophyll pigment concentration (chlorophyll a, b and c) while negatively correlated with BOD, turbidity, nitrate and phosphate concentration. This factor appears to be originated from the combined effect of anthropogenic activities accompanied with partial ecological recovery system of the estuary. Factor 2, on the other hand, explains 16.06% of the total variance and is negatively loaded with pH and COD. Since the causes of these two parameters are based on excessive industrial activities and these are removed instantaneously by the natural recovery system. The third factor represents 10.06% of the total variance related to biochemical oxygen demand (BOD) and can be termed as indicator of high microorganism growth, as mangrove waters containing organic matter regulates microorganisms. The fourth factor represents seasonal effects of water temperature at 4.81% level of variance. Factor loading plot (Figure 4) after varimax rotation revealed that the transparency, dissolved oxygen in surface water and chlorophyll a concentration are showing positive loading whereas turbidity, BOD and nitrate concentration showing negative loading. The study revealed the major causes of water quality deterioration which were related to untreated or semitreated wastes from domestic, agricultural and industrial sources along with discharge of dredged materials, storm water runoff, aerial fall out, oil spills, boating and other nonpoint sources. Clustering dendrogram (Figure 5a-c) revealed the clustering of the sampling stations depending on the different seasons. In the monsoon season station Lower long sand (S_2) and Jambu Island (S_4) clustered at about 70% level of similarity overlapping with each other. Both of these two stations are the offshore stations situated on the Bay of Bengal revealing same kind of hydrological patterns. During the postmonsoon season all the stations clustered at about >85% level of similarity.

7. Ecological best designated use

Some ecological parameters were used to decide the best use of the river Hugli flowing in Sundarban coastal region with its numerous tributaries, like irrigation, industrial processing, drinking water resource, bathing, propagation of wildlife, navigation, fishery, recreation, controlled agricultural and aquacultural waste disposal. Based on the parameter values of pH, nitrate, phosphate, DO and COD and the maximum permissible limits for these parameters it may be concluded that the water from eastern flank of the Sundarban is suitable for bathing, wildlife fisheries, recreation and irrigation following water quality criteria for various designated best use as outlined by ADSORBS, 1982. However, in the eastern flank of Sundarban wetland, high phosphate level and low DO level have made this water unfit for fisheries and agricultural use. High COD level in the water does not imply any pollution problem in this area as this high COD can be ascribed from the inundation of the mangrove forest (Romerio-Harnandez, 2003).

8. Conclusion

The deterioration of water quality in the coastal regions of Sundarban wetland is closely related to insufficiency to water resource protection, nonfunctioning of wastewater

treatment facilities and lack of environmental planning and coordination. Socio-economic issues must be integrated with proper management of water resources in general and with providing an adequate quantity and quality of water for the human populations and for industrial, agricultural and recreational usages. To achieve the target of regional sustainability, socio-economic issues must be considered with scientific management of water resources involving stakeholders, business sector, non-governmental organizations (NGOs) and the public. The authors strongly recommend the following basic components: (i) baseline and monitoring studies (ii) water quality criteria establishment (iii) identification of sources, pathways and analysis of pollutants and (iv) pollution control, abatement and rehabitation.

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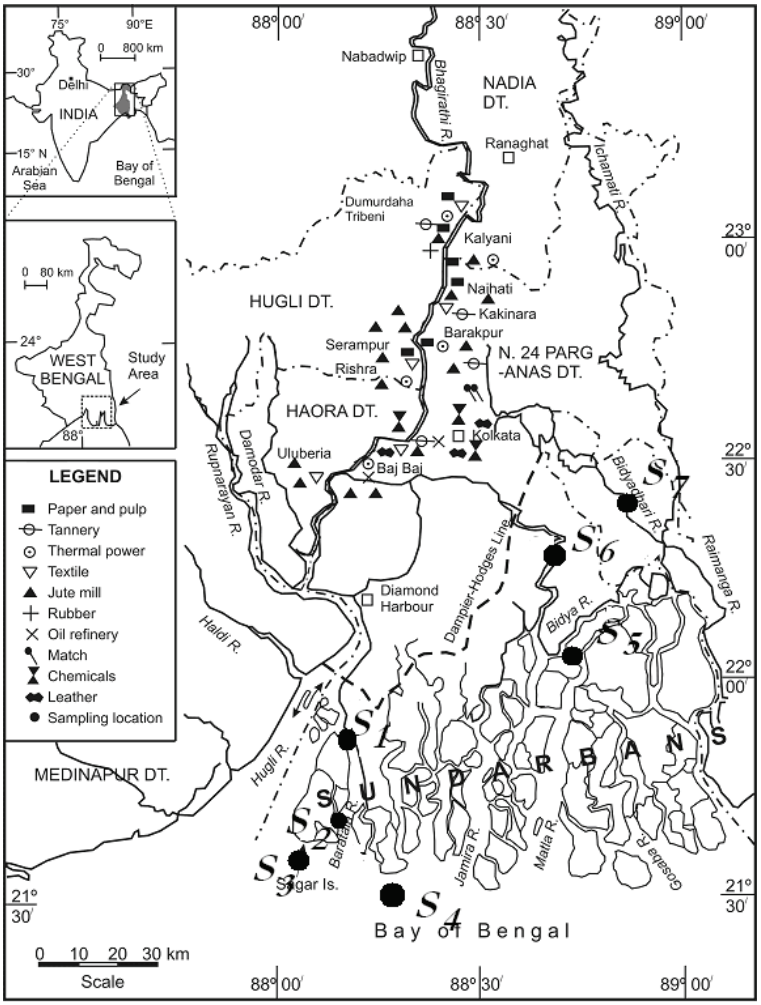


Fig. 1. Map showing the sampling sites in Sundarban wetland

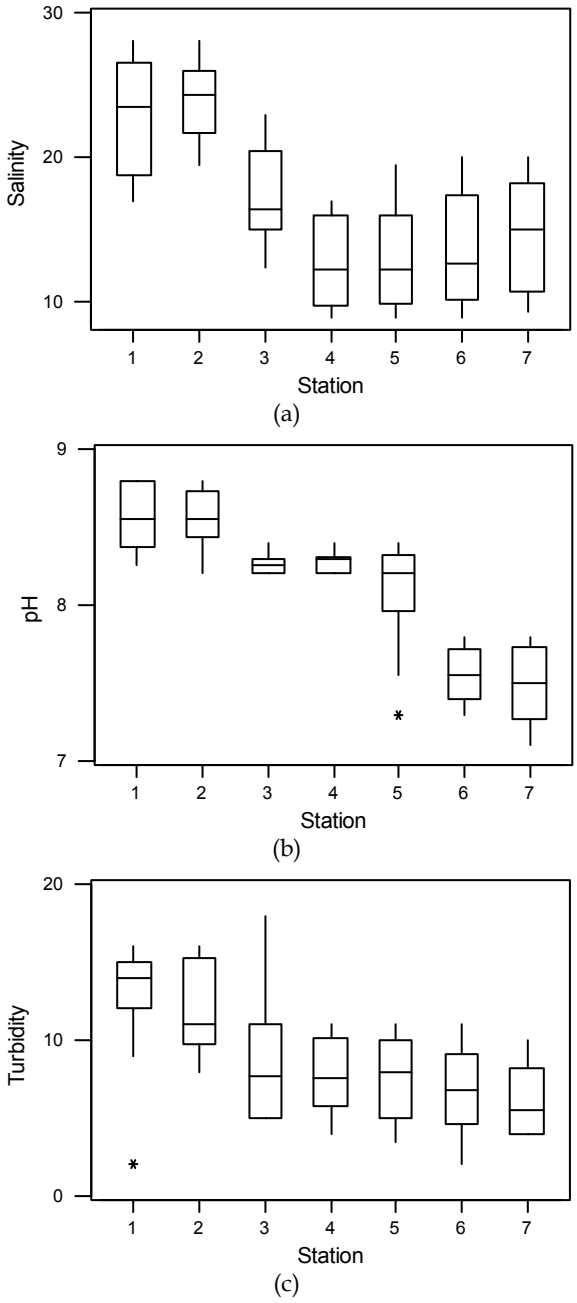
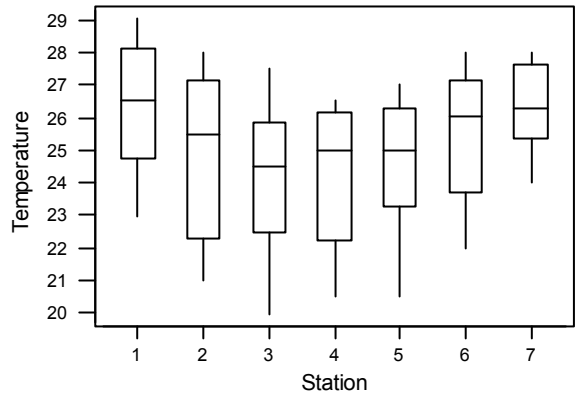


Fig. 2(a-c). Box plot diagrams of the 14 water quality parameters form coastal waters of Sundarban wetland



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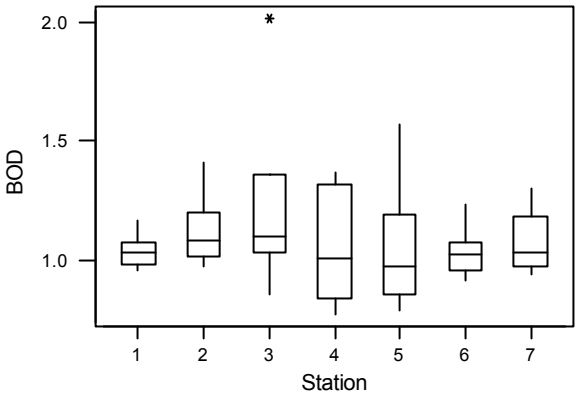

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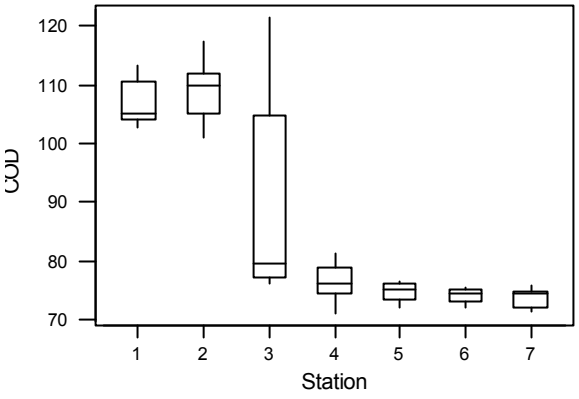
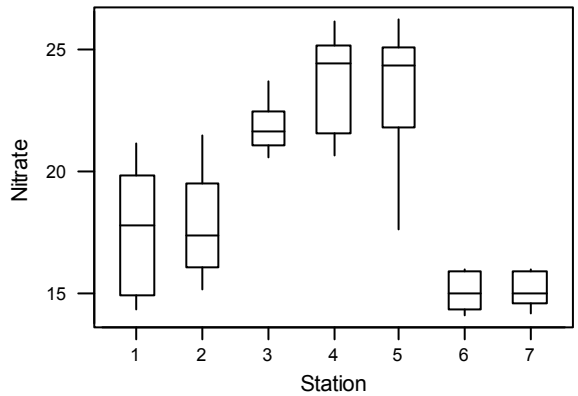
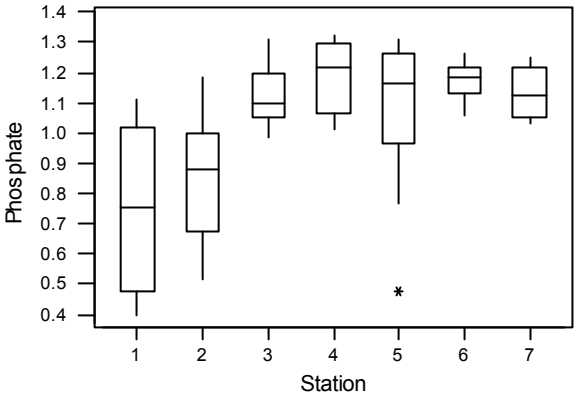


(f)

Fig. 2(d-f). Box plot diagrams of the 14 water quality parameters form coastal waters of Sundarban wetland



(g)



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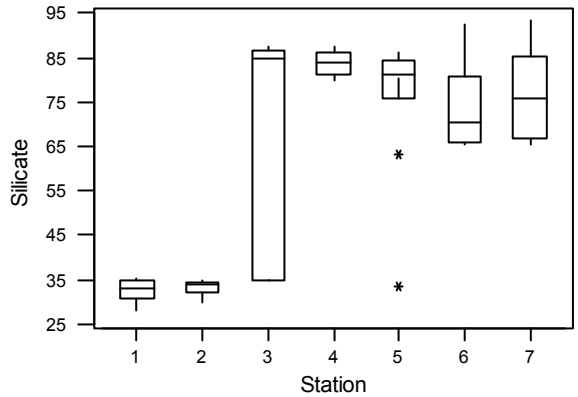
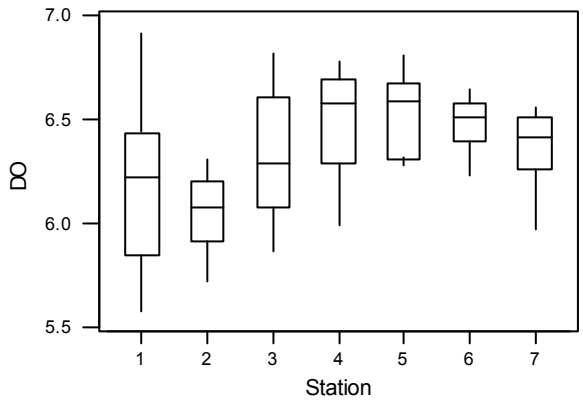
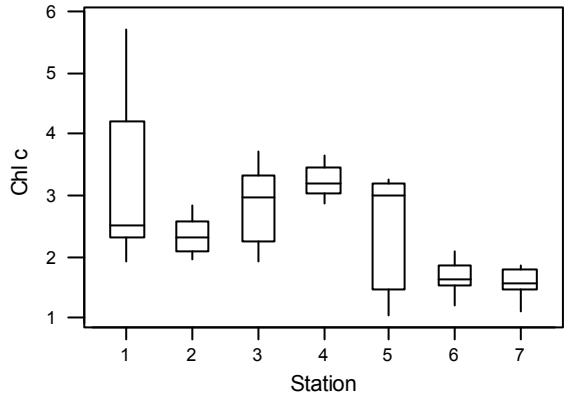


(i)

Fig. 2(g-i). Box plot diagrams of the 14 water quality parameters form coastal waters of Sundarban wetland



(j)



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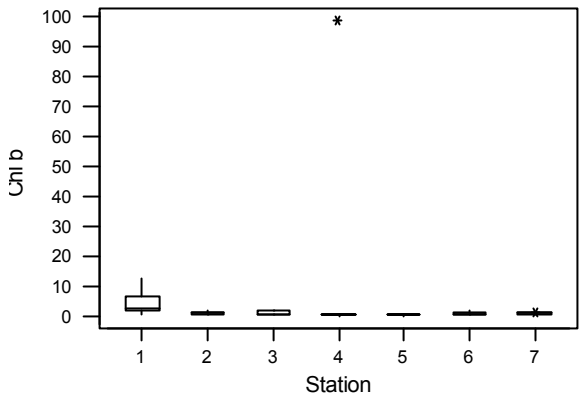
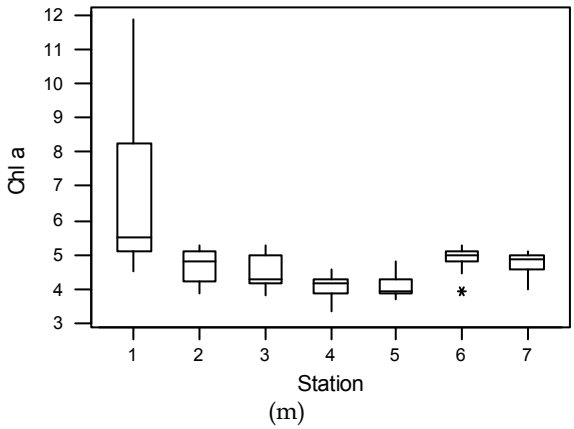


(l)

Fig. 2(i-l). Box plot diagrams of the 14 water quality parameters form coastal waters of Sundarban wetland



(m)

Fig. 2(m). Box plot diagrams of the 14 water quality parameters form coastal waters of Sundarban wetland

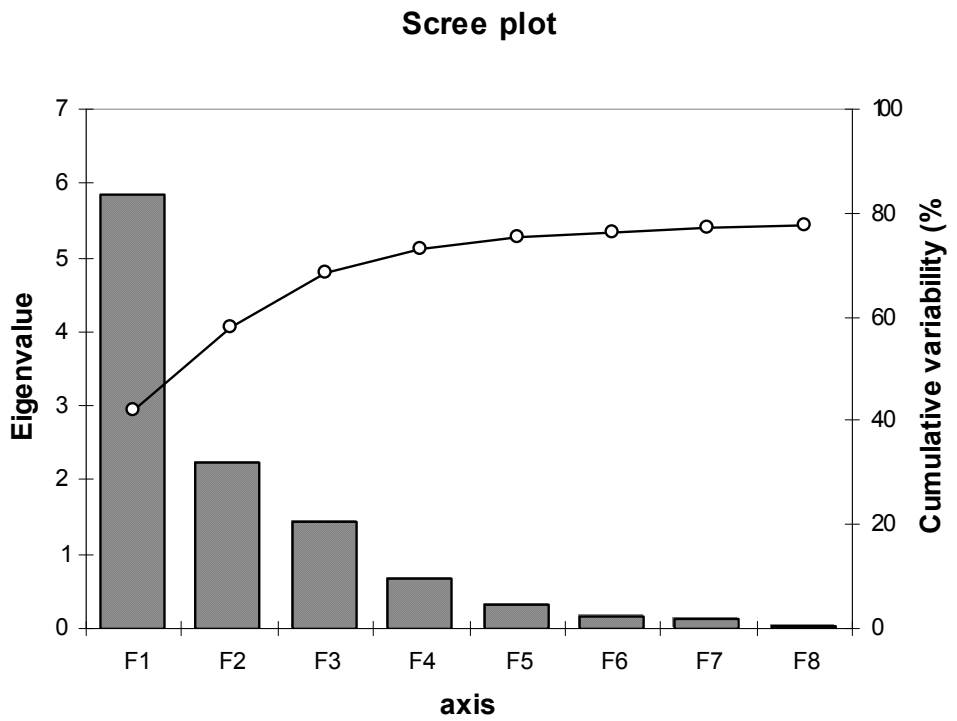


Fig. 3. Scree plot of the factor analysis after varimax rotation

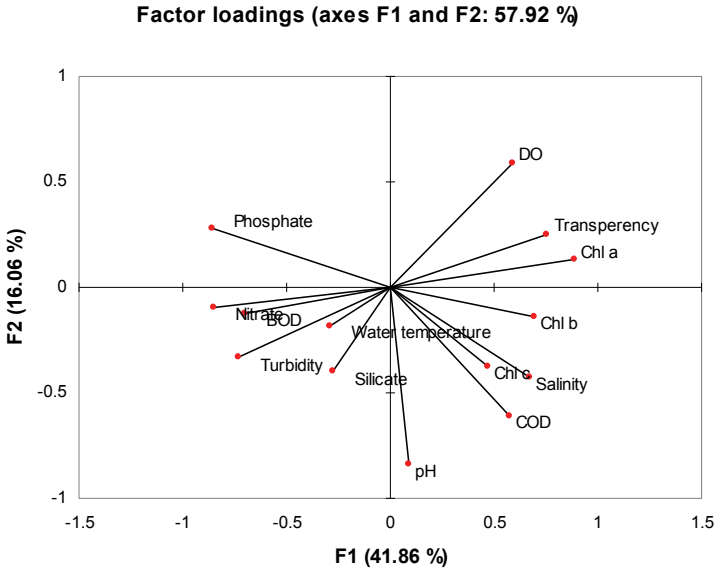
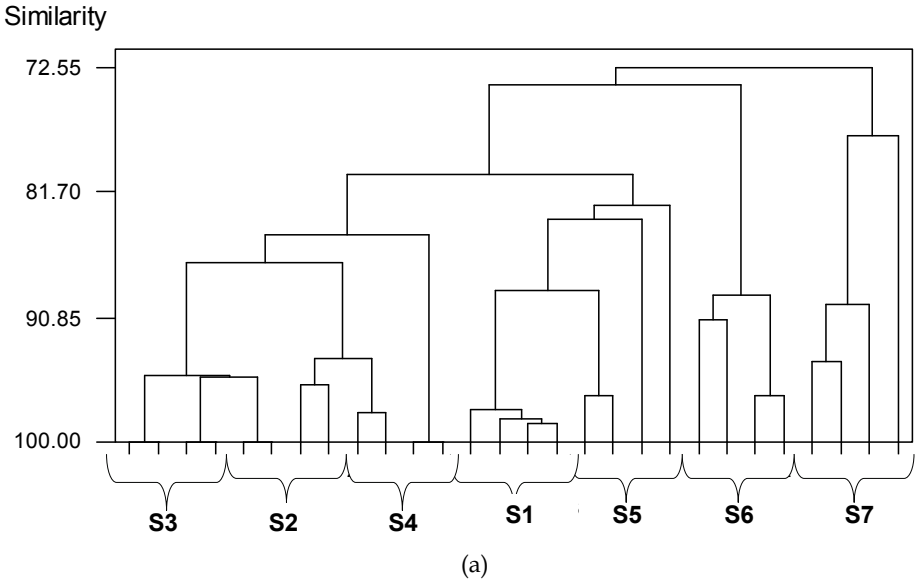
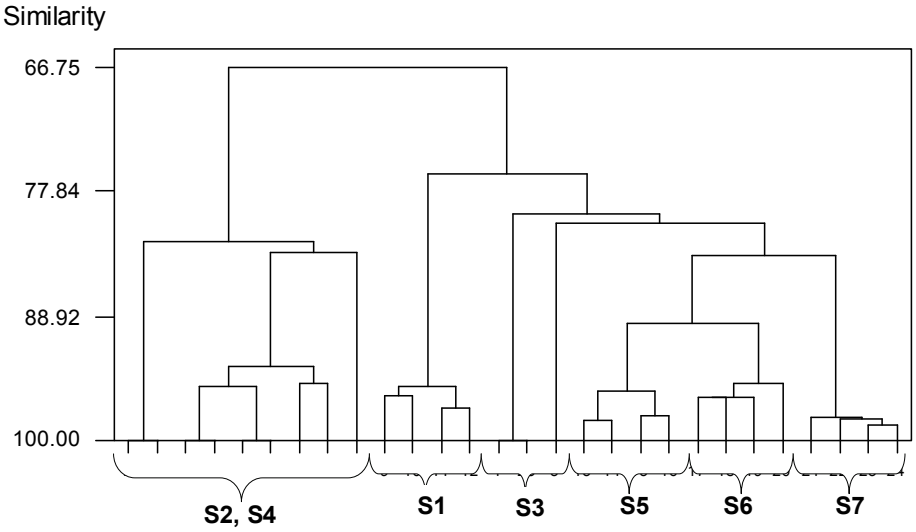


Fig. 4. Factor loading plot of the water quality parameters



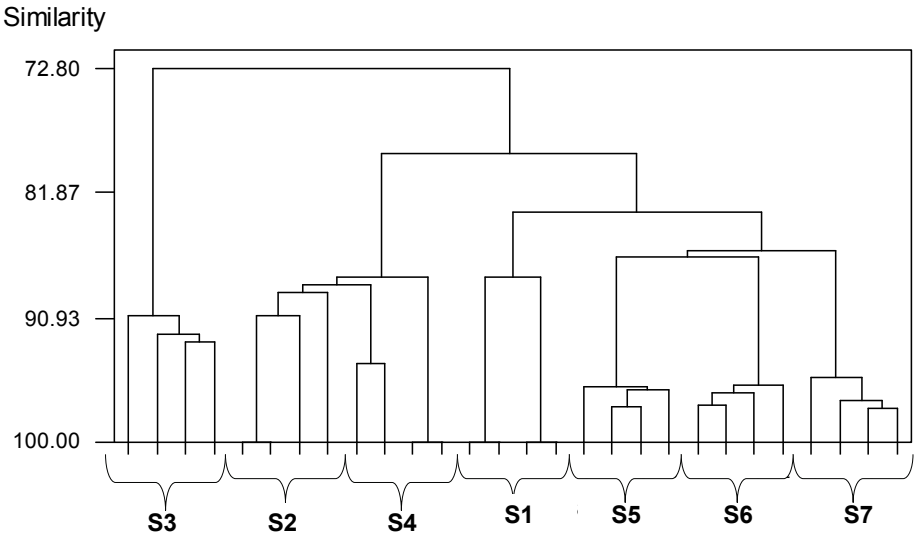
(a)

Fig. 5. Clustering dendrogram of the seven studied stations (S_1 – S_7) depending on the water quality parameters for (a) premonsoon



(b)

Fig. 5. Clustering dendrogram of the seven studied stations (S_1 – S_7) depending on the water quality parameters for (b) monsoon



(c)

Fig. 5. Clustering dendrogram of the seven studied stations (S_1 – S_7) depending on the water quality parameters for (c) postmonsoon seasons

	F1	F2	F3	F4
Water temperature	-0.291	-0.184	0.037	**0.418**
Salinity	**0.673**	-0.430	0.412	-0.243
Turbidity	**-0.733**	-0.333	0.402	0.095
Transperency	**0.756**	0.248	0.473	-0.163
pH	0.089	**-0.837**	0.030	-0.153
DO	**0.593**	0.587	-0.143	-0.021
BOD	**-0.703**	-0.126	**0.520**	0.161
COD	0.573	**-0.609**	0.006	0.123
Nitrate	**-0.848**	-0.093	0.155	0.006
Phosphate	**-0.855**	0.279	0.120	0.073
Silicate	-0.274	-0.398	**-0.691**	-0.185
Chl a	**0.890**	0.130	0.019	0.436
Chl b	**0.696**	-0.141	0.304	0.024
Chl c	**0.468**	-0.379	-0.296	0.327
% of variance	41.86	16.06	10.36	4.81
Cumulative	41.86	57.91	68.27	73.09

Table 1. Factor analysis of the water quality parameters after varimax rotation

Parameter	USPH standards[a]	WHO standard
pH	6.0 - 8.5	6.5 - 9.2
DO	4.0 - 6.0	-
Nitrate	<10	45
Phosphate	0.1	-
COD	4	10

Except pH, all units are in mg l^{-1}

A Maximum permissible concentrations

Table 2. Drinking water standards as recommended by USPH and WHO

9

Interaction between Heavy Metals and Aerobic Granular Sludge

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1. Introduction

Metals play important roles in the life processes of microbes. Some metals, such as Fe, Zn, Cu, Ni, and Co are of vital importance for many microbial activities when occur at low concentrations. These metals are often involved in the metabolism and redox processes as parts of enzyme cofactors or participators in the electron transfer in microbial respiration (Zandvoort et al., 2006). However, metals at high concentrations are inhibitory or even toxic to living organisms. Essential metals in the enzymes can be displaced by toxic metals which have the similar structure, thus resulting in the enzymes inactivation or damage (Bruins et al., 2000).
Heavy metals contaminants have posed great challenge to wastewater treatment. Large quantity of heavy metals are released from mineral rock weathering and anthropogenic sources such as metalliferous mining and smelting, electroplating, batteries, fertilizers, and pigments industries (Sirianuntapiboon & Ungkaprasatcha, 2007; Ong et al., 2005a). Due to their high toxicity and environmental recalcitrance, remediation of heavy metal is of urgent importance. Many techniques have been tried out to remove heavy metals from wastewater. Physicochemical methods, such as chemical precipitation, ion exchange, adsorption, electrolysis, chemical oxidation/reduction and membrane technologies, are found to be ineffective or rather expensive or generate toxic slurries (Liu et al., 2003; Pamukoglu & Kargi, 2006). Biological treatment is considered a promising technique for bioremediation of heavy metals wastewater, since it can degrade organic pollutant in the wastewater and simultaneously transform heavy metals.
Aerobic granulation is a novel environmental biotechnological technique which draws intensive interest in the last 20 years. Aerobic granules, as defined as self-immobilized microbial aggregates, are usually cultivated in sequencing batch reactors (SBRs). When compared with conventional activated sludge, the aggregation of microorganisms into compact granules brings extra benefits such as excellent settleability, high biomass retention, diverse microbial structure, and the ability to resist high organic and toxic loadings (Su & Yu, 2005; Tay et al., 2001). Due to the excellent abilities of aerobic granular sludge, they have been employed to treat wastewaters containing organic pollutants, N, P, heavy metals, and dyes etc (Beun et al., 2001; Chen et al., 2008; Cheng et al., 2008; Liu et al., 2009; Wang et al., 2007; Wang et al., 2010).

Heavy metals can be transformed into states with low mobility or toxicity by aerobic granules through physicochemical and biological processes. Cell walls and the extracellular polymeric substances (EPS) provide rich binding sites for metals. Microbial activities of aerobic graules are also capable of metal detoxification. Moreover, the unique layer structure of aerobic granules gives them addiditional advantages in metal-resistance. While bioremediating heavy metals, microbial activities of granules are stimulated or inhibited by metals depending on their concentrations. Aim of this study was to give a detailed description of the interaction between heavy metals and aerobic granular sludge, including possible metal-microbe interplay patterns, main metal uptake behaviour and mechanism, influence of metals on the reactor performance, and the metal-resistance strategies of aerobic granules. Better understanding of these interactions and influence factors helps to raise rational operation strategies for the bioremediation of heavy metals wastewaters.

2. Metal-microbe interaction and metal speciation

Bioavailability of heavy metals highly depends on environmental conditions, such as pH, alkalinity, redox potential, and activities of microorganisms (van Hullebusch et al., 2005a). Heavy metals mainly exist in the forms of Me^{2+}, $MeSO_4$, and $MeCl^-$ at pH<7, while $MeHCO_3^+$ and $MeCO_3$ are dominant at pH>7 (Hietala & Roane, 2009). In the study of Sandrin & Maier (2002), the ionic cadmium (Cd^{2+}) concentration at pH 4 was 44 mg/L while it decreased to 4 mg/L at pH 7. Metal bioavailability is enhanced under acidic conditions, thus increasing the potentional metal toxicity. Metal bioavailability is also influenced by redox potential. High redox potential (800 to 0 mV) favors metal solubility while low redox potential (0 to -400 mV) immobilises metal in precipitated forms (Hietala & Roane, 2009).

Microbial bioremediation affects the fate of heavy metals. Heavy metals can not be degraded in microbial metabolism/co-metabolism process. Bioremediation of heavy metals is accomplished by the conversions between inorganic and organic forms or the inorganic valence changes through redox (Ramasamy et al.,2007). At least four general approaches are involved in the bioremediation of heavy metals, which are summarized in Fig.1.

1. Biosorption

Biosorption between positively charged heavy metals and negatively charged cell walls occurs commonly in the biological treatment system. Moreover, cell walls and EPS secreted by cells consist of complex substances, such as lipopolysaccharides, proteins and carbohydrates. These chemicals contain abundant functional groups which provide sorption sites for metal binding and metal immobilization.

2. Intracellular bioaccumulation

Heavy metal can be accumulated within cells via membrane transport systems. Heavy metals are first bound to extracellular ligands and then get transported through cell wall with these ligands. Once inside the cell wall, metals are inactived, localized within intracellular structures, or participate in biochemical process (Sigg, 1987).

3. Direct enzymatic reduction

The principle of reductive biotransformation of heavy metals lies on the decrease of mobility and toxicity when metals are reduced to lower redox states. In the direct reduction process, metal-reducing microorganisms use the oxidized form of metals (such as Cr (VI), U (VI), and Tc (VII)) as electron accepters and transform them into reduced species (Cr (III), U (IV), and Tc (IV)). Aerobic or anaerobic reduction of Cr (VI) to Cr (III) has been accomplished by a wide range of microorganisms (Kamaludeen et al., 2003).

4. Indirect enzymatic reduction

Reductive biotransformation also facilitates indirect metal immobilization. Metal-reducing and sulfate-reducing bacteria are usually involved in this process. Electrons extracted from the oxidation of organic compounds or hydrogen are used to reduce Fe (III), Mn (IV), and SO_4^{2-} to Fe (II), Mn (III), and H_2S. Heavy metals then interact with these reduced products to form separate or multicomponent insoluble species (van Hullebusch et al., 2005b). Indirect enzymatic reduction often happens in sedimentary and subsurface environments or in anaerobic wastewater treatment reactors. The most active reduced products are Fe (II) and H_2S. Fe (II) is used as electron donor in the reduction of Cr (VI) to Cr (III) by Fe-reducing bacteria, such as *Geobacter, Desulfuromonas, Shewanella*, and *Pelobacter*. (Coates et al., 1996; Wielinga et al., 2001). Heavy metals in up-flow anaerobic sludge bed (UASB) reactors are often precipitated by sulphide produced by sulphate biological reduction, which enables the simultaneous removal of heavy metal, sulphate, and organic pollutants (De Lima et al., 2001; Sierra-Alvarez et al., 2006).

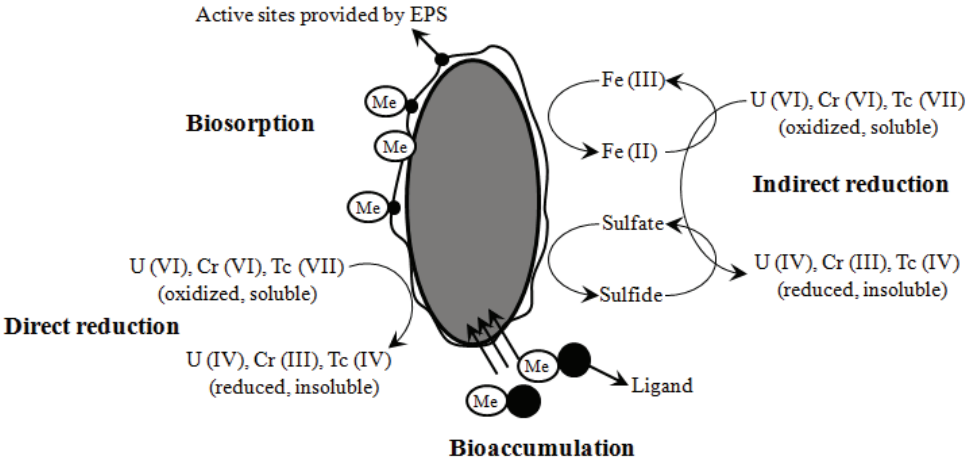

Fig. 1. Possible metal-microbe interaction

The speciation and bioavailability of heavy metals are highly affected by the physicochemical properties of wastewater treatment system and microbial activities. Heavy metals in the system usually can be classified to five groups (Li et al., 2009; van Hullebusch et al., 2006):

1. Exchangeable fraction
2. Carbonate fraction
3. Fe/Mn oxide-combined fraction
4. Organic matter/sulfides bound fraction
5. Residual fraction

Property of each fraction varies, making the total heavy metals concentration a poor indicator of metal bioavailability and toxicity. The residual and exchangeable fractions possess the highest mobility, since these metals can be easily released through ion exchange. Metals trapped in the Fe/Mn oxide will be leached if redox condition in the system changes. Organic matter always has high affinity towards heavy metals. However, decomposition or oxidation of organic ligands occur with time, resulting in the exposure of heavy metals. Sulfide fraction is insoluble and thus exhibits lower toxicity. However, chemical states of

sulfide are dependent on the system conditions. Metal release happens during the oxidation of sulfide precipitate under oxygen-rich conditions (Salomons, 1995).

3. Biosorption of heavy metals by aerobic granular sludge

Bioremediation of heavy metals can occur through several pathways. However, biotic and inactive sludge show limited differences in metal uptake capacity in batch mode studies. Sirianuntapiboon & Ungkaprasatcha (2007) studied the uptake capacity of bio-sludge towards Pb^{2+} and Ni^{2+}. It was found that the uptake capacity decreased by 10-30% after autoclaving, indicating the significant role of adsorption in the remediation process.

3.1 Biosorption behavior of aerobic granular sludge

Various biosorbents, such as fungus, algae, bacteria, and activated sludge, have been used to remove heavy metals. The maximum adsorption capacities for Cd^{2+} of these biosorbents lie in a range of 22-153 mg/g, and those for Zn^{2+} and Cu^{2+} were 14-170 and 5.9-130 mg/g dry biomass (Liu et al., 2004). Table 1 summarizes the maximum adsorption capacities of granular sludge and some commercially available adsorbents. As can be seen from Table 1, aerobic granules have comparable adsorption capacities with other biosorbents. Furthermore, the dense structure and excellent settling ability of aerobic granular sludge make it more feasible than those suspended biosorbents. Aerobic granules also exhibited high removal capacities when compared with some commercially available resins and granular activated carbon (GAC).

Biosorption of heavy metals is a rapid process and usually reaches equilibrium within several hours. The adsorption process experiences a relatively fast initial sorption followed by a slower and longer uptake. At the beginning of adsorption, a large number of vacant active sites are available for heavy metals, and the driving force provided by the metal concentration differences between the granule surface and solution is large. As the active sites are gradually occupied by metals, the adsorption process slows down. Heavy metals can enter the pores within the granules and subsequently get adsorbed. However, the interior adsorption needs to overcome lager mass transfer resistance.

The adsorption capacity depends on various system parameters, such as pH, temperature, and ionic strength. Among them, pH is the most important factor by affecting the chemistry of both the biomass surface and heavy metals. The adsorption capacities of aerobic granules are usually enhanced at higher solution pH. For example, the biosorption capacities of aerobic granules increased from ~20 mg Pb^{2+}/g to 44 mg Pb^{2+}/g when the solution pH was increased from 3.0 to 4.0 (Yao et al., 2008). Cu (II) adsorbed by aerobic granules at pH 3 was 19.25 mg/g and that at pH 5 was 36.72 mg/g (Gai et al., 2008). It is believed that the biomass surface is protonized at low pH. The protonized ligands and metal cations will compete for binding sites. As the pH increases, more functional groups with negative charges become exposed, which results in the biosorption capacity enhancement (Gai et al., 2008; Hawari & Mulligan et al., 2006a). Higher temperature always favors the adsorption process through the increase in surface activity and kinetic energy of the solute (Sag & Kutsal, 2000). However, the influences of temperature are usually insignificant and operating the adsorption system at high temperature is impractical.

Table 1 also shows even in the same system, the adsorption affinity varies for different metals. The metals are adsorbed preferentially in the order of Pb (II)> Zn (II)> Cu (II)> Cd (II)> Ni (II)> Co (II), which maybe related with the covalent index of metal ions (Brady & Tobin, 1995; Leung et al., 2001; Puranik & Paknikar, 1999).

Adsorbent	Metal	q_{max} (mg/g dry biomass)	pH	Reference
Aerobic granules	Cd (II)	566	7	Liu et al, 2003
Aerobic granules	Pb (II)	87.7	5.5	Yao et al., 2008
Aerobic granules	Co (II)	55.5	7	Sun et al., 2008
	Zn (II)	62.5	5	
Aerobic granules	Cd (II)	625	7	Liu et al., 2004b
	Zn (II)	204	6	
	Cu (II)	52.9	5	
Anaerobic granules	Co (II)	8.4	6	van Hullebusch et al., 2004
	Ni (II)	7.9		
Calcium treated anaerobic granules	Pb (II)	255	5.5	Hawari & Mulligan, 2006a
	Cd (II)	60		
	Cu (II)	55		
	Ni (II)	26		
Commercial resins Duolite GT-73	Pb (II)	122	4.5-5.0	Vaughan et al., 2001
	Cd (II)	105		
	Cu (II)	61		
	Ni (II)	60		
Commercial resins Amberlite IRC-718	Pb (II)	290	4.5-5.0	Vaughan et al., 2001
	Cd (II)	258		
	Cu (II)	127		
	Ni (II)	129		
GAC	Pb (II)	26	4.0-4.5	Suh & Kim, 2000

Table 1. Maximum adsorption capacities (q_{max}) of different sorbents towards heavy metals

3.2 Metal speciation in aerobic granular sludge and adsorption mechanism

Several mechanisms have been proposed for the uptake of heavy metals by biomass, including ion exchange, complexation, and precipitation. Table 2 summarizes the contribution of different mechanisms in some biosorption processes. Among them, ion exchange seems to be dominant except in the study by Yao et al. (2009), where complexation is mainly responsible for the heavy metal uptake.

Heavy metal sorption is associated with the simultaneous release of light metal ions (Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}) in the ion exchange process. Light metal cations, especially Ca^{2+}, are found to enhance sludge granulation, and thus are always added in the granulation process (Jiang et al., 2003; Mahoney et al., 1987). One of the possible promotion mechanisms is the formation of EPS-Ca^{2+}-EPS bridge or cell-Ca^{2+}-cell linkage (Liu et al., 2002). Sites initially occupied by these light cations are substituted by metals in the adsorption process.

Heavy melts biosorption by complexation is accomplished by binding of metals to EPS. EPS is a mixture of macromolecular polyelectrolytes including polysaccharides, proteins, and nucleic acids. EPS is an essential component for the aerobic granulation and the subsequent three-dimensional matrix maintenance (Sheng & Yu, 2006). In addition, the abundant functional groups, such as carboxylate, hydroxyl, amide, and amine groups, create complexation sites for metal binding. EPS produced by *Paenibacillus jamilae* had a maximum complexation capacity of 230 mg Pb/g EPS (Morillo et al., 2006). Loosely bound EPS (LB-

EPS) and tightly bound EPS (TB-EPS) were extracted from aerobic granules and used as biosorbents to remove Zn^{2+} and Co^{2+} (Sun et al., 2009). Results show that LB-EPS was more efficient in heavy metals uptake than TB-EPS. The adsorption capacities of LB-EPS and TB-EPS for Zn^{2+} were 6.9 and 1.1 mg/mg EPS respectively and those for Co^{2+} were 5.5 and 1.5 mg/mg EPS. Xu & Liu (2008) studied the metal-EPS complexation in aerobic granules by fourier transform infrared (FTIR) spectroscopy. Table 3 summarizes the main functional groups on aerobic granules and the FTIR spectroscopy changes after metal adsorption. The main functional groups involved in the metal binding were alcoholic, carboxylate, amine and ether groups. Realizing the important role of functional groups, Sun et al. (2010) used polyethylenimine to enhance amine groups on aerobic granules. This surface modification successfully increased the Cr (VI) uptake capacity of granules by 274%.

Adsorbent	Metal	Adsorption mechanisms			Reference
		Ion exchange (%)	Complexation (%)	Precipitation (%)	
Aerobic granules	Cd (II)	75.51	19.36	5.13	Xu & Liu, 2008
	Cu (II)	71.31	16.19	12.50	
	Ni (II)	82.43	14.20	3.37	
Anaerobic granules	Pb (II)	51	20	29	Hawari & Mulligan, 2006b
	Cu (II)	77	18	0	
	Cd (II)	82	15	0	
	Ni (II)	98	0	0	
Aerobic granules	Cr (III)	11.2	60.3	18.7	Yao et al., 2009
Aerobic granules	Cu (II)	~70	Unknown	Unknown	Gai et al., 2008

Table 2. Contribution of different mechanisms to heavy metals biosorption

Except ion change and complexation, heavy metals can also be removed from aqueous solutions by chemical precipitation. New crystals as $CdCO_3$ and $Cu_2(OH)_3Cl$ were detected in aerobic granules by X-ray diffraction analysis (XRD) after exposure to Cd^{2+} and Cu^{2+} (Xu & Liu, 2008). As compared with ion exchange and complexation, the distribution of precipitation was minor (Table 2).

4. Effects of heavy metals on the aerobic granular sludge system

Heavy metals occurring at low concentrations are essential for many physiological and biochemical processes of microorganisms. Metals are often involved in the enzyme system. Co works as a cofactor in vitamin B_{12} and methyltransferase which play key roles in methylotrophic methanogenic pathway (Beveridge & Doyle, 1989). Ni is essential for methyl-CoM-reductase and uerase while Fe and Cu are of vital importance for NO-reductase, nitrite reductase, and ammoniummonooxygenase (Ensign et al., 1993; Ferguson, 1994; Hausinger, 1994). While acting as essential trace elements for microbial metabolism, metals at high concentrations introduce inhibition and toxicity to living organisms. Sandrin & Maier (2003) presented three inhibition patterns of heavy metals (Fig. 2). In the first pattern (Fig. 2A), the inhibition of heavy metals is proportional to their concentrations. In pattern B, low

concentrations metals simulate microbial activity while inhibition begins to show up at high metal concentrations. This phenomenon is usually found in the mixed consortia system. The simulation at low metal concentrations can be attributed to the differential toxicity effects. Metals may select for a metal-resistant, functional population while inhibiting a metal-sensitive, non-functional population. Differential toxicity effects reduce competition for resource needed by the metal-sensitive, non-functional population, thus resulting in apparent simulation. In pattern C, metals exhibit inhibition at low concentrations. However, inhibition, after a maximum level, becomes milder under higher metal concentrations. This may be the results of microbial community evolution for high metal-resistant microorganisms or more efficient detoxification mechanism induced at high metal concentrations.

Vibration type	Functional type	Wave number (cm^{-1})			
		Granules	Cd^{2+} loaded granules	Cu^{2+} loaded granules	Ni^{2+} loaded granules
Overlapping of stretching vibration of OH and NH	OH into polymeric compounds and amine	3407	3414	3346, 3335	3402
Asymmetric stretching vibration of CH_2		2928	2927	2928	2928
Stretching vibration of C=O	Carboxylic acids	1725	Intensity decrease	1725	Intensity decrease
Stretching vibration of C=O and C–N (amide I)	Protein (peptidic bond)	1648	1648	1648	1648
Stretching vibration of C–N and deformation vibration of N–H (amide II)	Protein (peptidic bond)	-----	1520	1535	1520
C-H bending		1488	1488	1468	1488
Bending of C–O–H	alcoholic group	----	1384	1385	1385
Deformation vibration of C=O	Carboxylic acids	1261	1245	1240	1244
Bending vibration of C–O	Polysaccharides	1082	1082	-------	1082
Stretching vibration of OH	Polysaccharides	1056	1056	1056	1056
"Fingerprint" zone	Phosphate/ sulphur functional groups	<1000	<1000	<1000	<1000

Table 3. Functional groups on aerobic granules and wave number changes in FTIR spectroscopy after heavy metals adsorption (Adapted from Xu & Liu (2008))

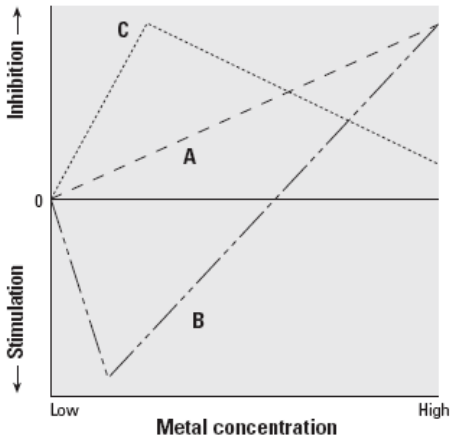

Fig. 2. Inhibition patterns of heavy metals (from Sandrin & Maier (2003))

4.1 Wastewater treatment performance in the presence of heavy metals

Wang et al. (2010) investigated the toxicity of Cu (II) and Ni (II) on aerobic granular sludge in SBRs. The reactors were operated with 5 mg/L Cu (II) or Ni (II) for 26 days and then the metals concentration was increased to 15 mg/L. Results show that biomass growth in the reactor was inhibited by 5 mg/L of Cu (II), while Ni (II) stimulated biomass yield even under the concentration of 15 mg/L. Influences of heavy metals on the SBRs treatment performance were shown in Fig. 3. Chemical oxygen demand (COD) and NH_4^+-N removal were slightly inhibited by 5 mg/L of Cu (II) in the first ten days. However, prolonged metal addition and increased metal concentration decreased COD degradation efficiency to 60%~80%. SBRs exhibited poor nitrification efficiency (~20%) when the concentration of Cu (II) was increased to 15 mg/L. Ni (II) had milder toxicity on aerobic granules activities when compared with Cu (II). Even at the concentration of 15 mg/L, Ni (II) caused slight reduction in COD and NH_4^+-N removal efficiency.

Evident NO_2^--N accumulation was observed in the first ten days of Cu (II) addition. Howver, COD degradation at this time was comparable with the metal-free control, indicating the sensitivity of nitrifying bacteria. The higher sensitivity of nitrifiers to heavy metals than heterotrophs are widely reported. Fluorescent in situ hybridization (FISH) analysis of Principi et al. (2006) revealed dramatic decrease in the abundance of *β-proteobacteria* under metal addition, which comprised ammonia-oxidizing bacteria. Stasinakis et al. (2003) also demonstrated nitrifying bacteria the most sensitive parts in the microbial community. Heavy metal can influence phosphorus removal through affecting alkaline phosphatase activity (APA). Zn^{2+} and Cu^{2+} at the concentration of 5.0 mM had an obvious inhibitive effect on the APA while Mn^{2+}, Co^{2+}, Pb^{2+} and Cr^{6+} ions stimulated the APA (Xie et al., 2010).

Among the metals investigated, Cu (II) always induces higher toxicity while Pb (II) processes the least toxicity (Lin & Chen, 1997; Li & Fang, 2007). Metals exert their toxicity on microorganisms through one or more mechanisms. Metal cations may substitute for physiologically essential cations within an enzyme (e.g., Cd^{2+} may substitute for Zn^{2+} or Ca^{2+}; Ni^{2+} substitutes for Fe^{2+}; Zn^{2+} substitutes for Mg^{2+}), thus inhibiting the function of the

enzyme (Nies, 1999). Metal oxyanions may take place of essential nonmetal oxyanions who are structurally similar with them. For example, arsenate may be used in place of phosphate. Besides the inactivation or damage of enzymes, Cu (II) also cause cytoplasmic membrane disruption. As a redox-active metal, Cu (II) can catalyze the production of free hydroxyl radicals and promote membrane lipid peroxidation (Howlett & Avery, 1997; Hu et al., 2003).

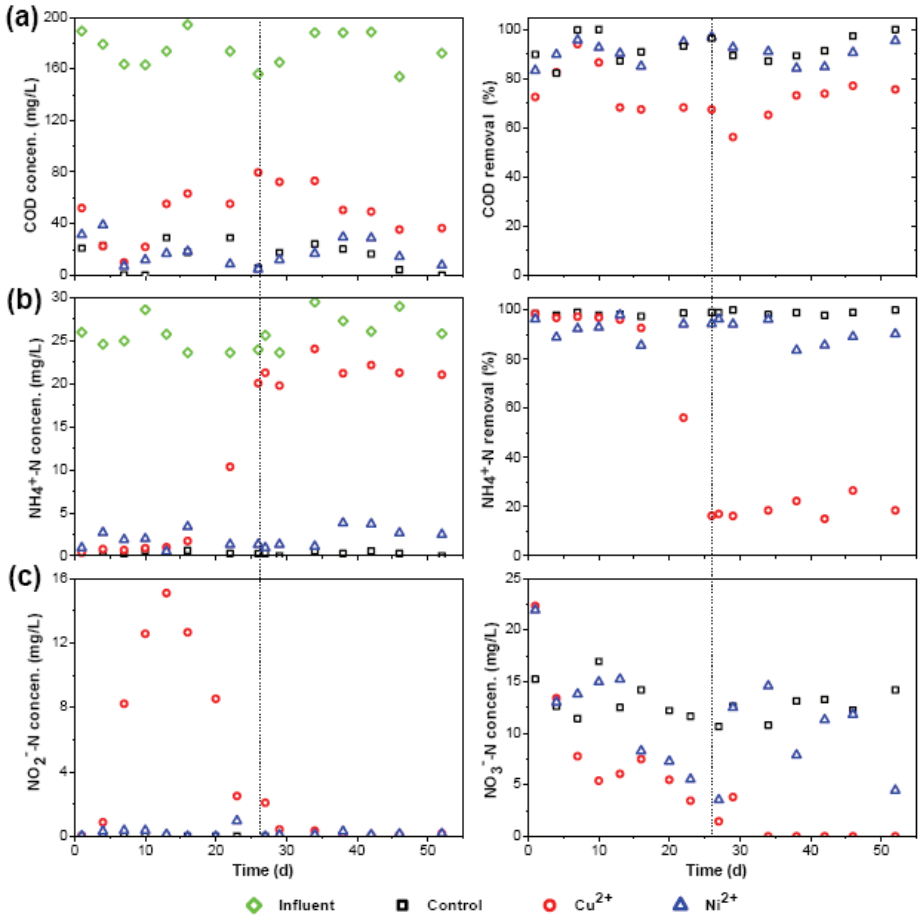

Fig. 3. Influence of heavy metals on wastewater treatment in aerobic granular sludge system: (a) and (b) COD concentration and removal efficiency; (c) and (d) NH_4^+-N concentration and removal efficiency; (e) NO_2^--N concentration and (f) NO_3^--N concentration (from Wang et al. (2010))

4.2 Metal resistance of granular sludge

Many researchers studied the effects of heavy metals on activated sludge system (Ong et al., 2004; Ong et al., 2005b; Santos et al., 2005; Sirianuntapiboon & Ungkaprasatch, 2007; Tsai et al., 2006). However, results from these studies are difficult to be compared due to the

various metal bioavailability caused by different operation modes, substrate compositions, seed sludge sources and concentrations. The total organic carbon (TOC) removal efficiency of activated sludge process decreased from 98% to 88% in the presence of Ni (II) while the same Ni (II) loading rate exerted slight influence on aerobic granules system (Ong et al., 2004; Wang et al., 2010). Table 4 gives the metal/VSS ratios causing 50% inhibition of microbial activity of anaerobic granules and flocculent sludge. Results show that granules always had higher toxicity-resistance than flocculent sludge.

Metal	Specific methanogenic activity [a]		Acetate degradation [b]		Methane production [b]	
	UASB granules	Flocculent sludge	Intact granules	Disintegrated granules	Intact granules	Disintegrated granules
Cd	>400	14.3	660	610	630	480
Cr	310	27.4	770	660	510	380
Cu	180	23.3	580	520	360	260
Ni	120	745	450	300	240	180
Zn	105	29.8	250	210	170	120

[a] Adapted from Lin 1993
[b] Adapted from Bae et al., 2000

Table 4. Metal/VSS ratios (mg/g VSS) causing 50% inhibition of sludge activity

Higher toxicity-resistance of granules is the benifit given by their unique physical, chemical, and biological properties, i.e., their compact sturcture, EPS, and dynamic microbial community. The spatial architecture of granules creates diffusion resistance. Taking dissolved oxygen (DO) as an example, it can only permeate 125 μm beblow the surface of a 1.50 mm phenol-fed granule (Chiu et al., 2007). Through diffusion resistance, granular sludge reduce the heavy metals concentrations within the granules.

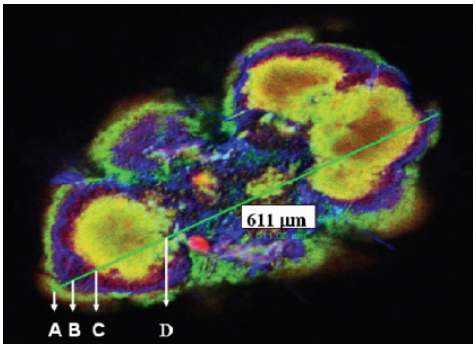

Fig. 4. EPS staining of a phenol-degrading granule. Green: proteins; red: nucleic acids; blue: polysaccharides; yellow: proteins + nucleic acid; purple: nucleic acids+polysaccarides; A-protein + nucleic acid layer, B-Polysaccharide layer, C-nucleic acid layer, D-protein + cells. (from Adav et al., 2007)

EPS acts as protective barrier in metal-resistance of aerobic granules. EPS, on one hand, reduces free metal concentrations by complexation, on the other hand, prevents toxicants from reaching microbes within the granules by diffusion limitation. Fig. 4 shows the EPS distribution in a phenol-degrading granule (Adav et al., 2007). The granule consists of a proteins and nucleic acids rich outer surface, followed by a polysaccharide layer. The inner core was filled with proteins and cells. This EPS matrix protected microorganisms from exposure to high concentrations of metals. Moreover, research also found that microorganisms could regulate EPS synthesis and modify EPS components (Sheng et al., 2005; Wang et al., 2010). They would secrete more EPS in the presence of heavy metals, especially more proteins. In the study of Sheng et al. (2005), the EPS content increased by 5.5, 2.5, and 4.0 times than the control when exposed to 30 mg/L Cu (II), 40 mg/L Cr(VI), and 5 mg/L Cd(II).

Diffusion limitation develops important physic-chemical gradients (e.g., pH, E_h and oxygen) in aerobic granules. These various physic-chemical environments enable diverse microbial community. Heterotrophic and autotrophic bacteria, aerobe and anaerobe coexist in aerobic granules. Microorganisms can alternate their metabolic pathways or redistribute themselves to acclimate to meal toxicity. Viret et al. (2006) studied the influence of Zn (II) and Ni (II) on oxygen consumption of benthic microbial communities. The oxygen consumption at the surface was found to decrease by 60%-90% after Zn (II) and Ni (II) spiking. However, the oxygen consumption zone was stretched, implying the migration of aerobe into inner space to avoid metal toxicity or/and the metabolism switch of facultative aerobic microorganisms to aerobic respiration which is more efficient than the original fermentation. Wang et al. (2010) applied Biolog tests to analyze the substrate utilization patterns of aerobic granules before and after long-term metal addition. Principal component analysis of the Biolog tests and the hierarchical cluster analysis showed different groups based on metal treatment, indicating changes in microbial community structure induced by Cu and Ni (Fig. 5).

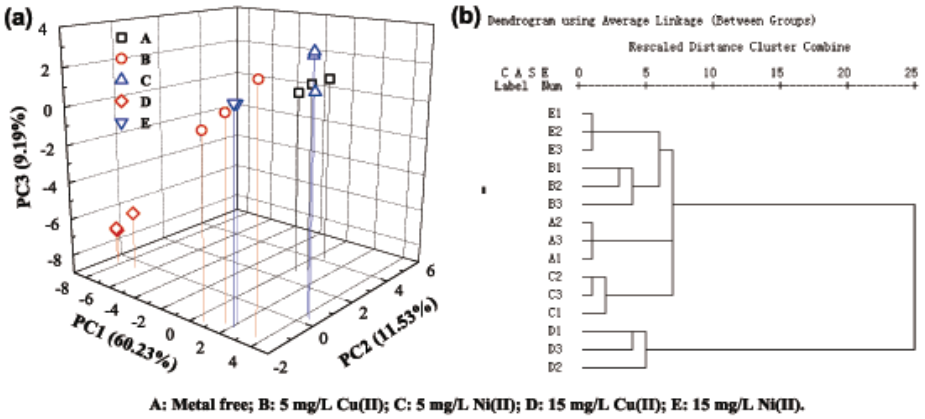

Fig. 5. Effects of heavy metals on the microbial community investigated by (a) principal component analysis and (b) hierarchical cluster analysis of Biolog tests. (from Wang et al. (2010)).

5. Conclusion

The interaction of heavy metals and aerobic granular sludge occurs on the surface and the inner space of sludge. These physical or biochemical processes are mainly based on sludge and are also influenced by environmental conditions and metal characteristics. Many studies have been conducted to uncover metals bioremediation by aerobic granular sludge and the effects of metals on sludge. These results are helpful for understanding the metal transformation and performance of aerobic granular sludge process.

In bioremediation of heavy metals by aerobic granular sludge, adsorption accounts for most metal uptake. The high biomass retention, compact and porous structure, and excellent settling ability of aerobic granules enable them good performance in the biosorption of heavy metals. Aerobic granules show high adsorption capacities when compared with other biosorbents and some commercial adsorbents. Heavy metals can be adsorbed to aerobic granules by replacing the sites of light metal ions (such as Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}) which already exist in the high content EPS, or binding to the functional groups on EPS and cell wall. Chemical precipitation on the metal–sludge interface also contributes to metal sorption to granules. Further experiments and characterizations of aerobic granule are needed to interpret space distribution of adsorbed metals and the adsorption mechanisms. Besides, good stability and unique structure of aerobic granules provide opportunity to enhance desired surface functional groups by chemical modification, which leads an important field in biosorption. Aerobic granules possess superior settling ability, so the removal of heavy metals in a continuous reactor similar as UASB or SBR maybe more hopeful.

Effects of heavy metals on the alive microbe are complicated, especially in the aerobic granular sludge reactor. The inhibition of heavy metal on aerobic granules depends on the metal species and concentrations. Organic pollutants degradation and nitrification are both negatively affected by the prolonged addition of high concentration heavy metals. However, higher toxicity-resistance than flocculent sludge has been proved in aerobic granules. This could be attributed to the unique compact structure and diverse microcosm. Diffusion resistance developed by the layer structure functions as barrier and buffer. The responses to heavy metal exposure are also of interest. Microbes in aerobic granules can regulate EPS synthesis and alternate their metabolic pathways to acclimate to meal toxicity. High concentration heavy metals should weaken the stability of whole microorganisms in the aerobic granules. Microbial test is a useful method for exploring sensitivity of different microorganisms to metals. Better understanding of metal biotransformation and responses of aerobic granules is essential for optimizing the aerobic granule reactor treating or exposed to heavy metals.

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10

High Mountain Ecosystems: How Much Love Can They Sustain?

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1. Introduction

Mountain ecosystems and high alpine peaks are symbolic of a delicate balance between the human need to use and to protect natural amenities. People spiritually and culturally identify with the serenity and beauty of high peaks (Blake, 1999; Blake, 2002), and are willing to pay a significant amount of money to access and enjoy them (Keske & Loomis, 2007; Loomis & Keske, 2009). However, mountain ecosystems are fragile, even with low level recreation use (McQuaid-Cook, 1978). Mineral extraction and other direct uses such as clear cutting have traditionally been used to drive mountain economies (Loomis, 2002). Although such extraction practices are often characterized as unsustainable, there is emerging evidence to suggest that current levels of recreation use can also be damaging to these ecosystems (Kedrowski, 2006). Even if information about environmental and development tradeoffs was available, preferences of rural mountain residents vary about how to define "sustainable" economic development and about acceptable levels of environmental damage.

This chapter outlines environmental and economic considerations for sustainable economic practices at high elevations, and discusses the economic value that visitors and residents place on high mountain recreation experiences. Recreation interests in mountain ecosystems has grown exponentially in recent years, and has provided relief to overburdened natural resources where it competes financially with more destructive commercial endeavors (Loomis, 2002). Despite the economic development and non-market value of high mountain recreation experiences, even passive use recreation may be considered unsustainable if it is not appropriately managed. That is, people can love these resources to death.

The purpose of this chapter is to examine the delicate, and unique, balance of economic and environmental tradeoffs in high mountain communities in the context of recreation. The question is: how much recreational love can these ecosystems sustain? The chapter proceeds with definitions of "sustainability" and methods for economic valuation. Next is a brief summary of pressing environmental and economic concerns within a case study area, the high elevation Park and Lake Counties, located in central Colorado (United States). The chapter presents results from economic studies conducted from 2006-2010, indicating that both recreators and residents place high value on the high mountain natural resources and lifestyles, even when compared to other natural experiences. Given the high potential for economic development, community residents and visitors to the region must consider trade-

offs between economic drivers and environmental quality. This requires the use of collaborative conservation techniques, which should be accompanied by setting targets for both conservation and economic development. Suggestions are presented for future policies and research that may balance both environmental and economic goals.

2. Defining sustainable development

A significant challenge for managing ecosystems is determining how to apply definitions of sustainability. To date, the most commonly recognized definition of sustainable development is provided by the World Commission on Environment and Development (1987). This report is often referred to as the "Brundtland Commission's report" after Norway's former prime minister Gro Harlem Brundland, who chaired the Commission. The Brundtland Commission's report defines sustainable development as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (p.43).

The report outlines three critical categories relevant to assessing sustainable economic development: economic, environmental, and social well-being. While the report clearly emphasizes that social and environmental values should not be sacrificed for the sake of improved economic prosperity, the Commission also recognizes that improvements to social and environmental quality are also positively correlated with economic development. In other words, a healthy economy can contribute to a healthy environment in the long run. Therefore, while the Brundtland Commission's definition of sustainable development is often regarded as ambiguous, many believe that this wide net is necessary in order to allow for communities to define what constitutes an appropriate balance of these three criteria. The difficulty often lies in being able to quantify or measure appropriate economic development (United Nations Economic Commission for Europe, 2010).

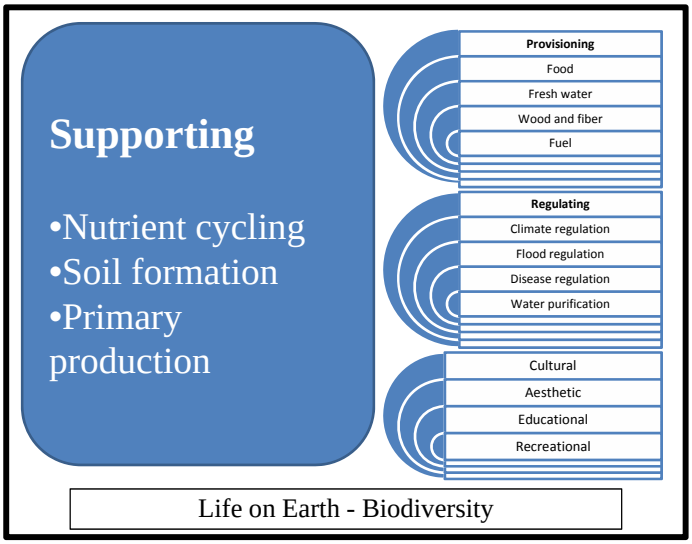
More recent international efforts on sustainable ecosystem management concur that social and cultural dimensions must be balanced with environmental quality, and this may be a difficult balance to achieve. The Millennium Ecosystem Assessment (MA) project was formed in 2000 after a directive by then-United Nations Secretary Kofi Anan to "...to assess the consequences of ecosystem change for human well-being and the scientific basis for actions needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being" (p.3).

As shown in Figure 1, adapted from the MA report, the MA defines four main categories of ecosystem services to support life on Earth and biodiversity. These categories include supporting, provisioning, regulating, and cultural ecosystem services. The MA recognizes that ecosystem services are human driven, and all four of these categories directly affect human well-being. While supporting, provisioning, and regulating ecosystem services reflect the more traditional "environmental goods", it is noteworthy that the cultural ecosystem services also reflect aesthetic, educational, and recreational opportunities. Thus, the connection has been made that there is a need to balance recreation with supporting ecosystem services such as soils and plants, reflective of high mountain regions.

3. Using economic valuation to measure sustainable development

Economics is the science of measuring trade-offs, and there is an abundance of economic tools that may be used to measure the trade-offs, or different values, humans place on

ecosystem services. Economists rely on prices to indicate whether a market is properly functioning, as price signals whether goods become more or less scarce (Friedman and Friedman, 1962). For example, for a given supply, as the demand for petroleum increases, so does the price, as there are more individuals competing for the same product. Suppliers can review the petroleum prices for feedback and adjust their production accordingly.



Adapted from "Living Beyond Our Means": Millennium Ecosystem Assessment (2005)

Fig. 1. Ecosystem services

However, economists concur that prices may not always reflect the "true economic value" of a good—particularly an environmental good. Some environmental goods, such as endangered species like panda bears, may not have a price that reflects their true value, as these animals are not traded through an open market. Other environmental goods such as a healthy ecosystem, are only given a price when there is environmental damage, as occurred in the case of the Exxon Valdez oil spill in Alaska's Prince William Sound.

When valuing environmental goods, economists pull out a special "toolkit" to model the value of environmental goods and ecosystem services. Environmental values consist of both a "use" and "nonuse" components, which are summarized in Figure 2. Use values typically consume the resource, such as hunting deer, while non-use values do not consume the resources, such as photographing deer. Economists use different tools or models to determine the value of environmental goods. For a full accounting of the economic value of a good, both the use and non-use values should be considered.

As shown in Figure 2, the use dimension is divided into two classes: direct use and indirect use. Direct use occurs when humans utilize a resource. Economists value this direct use component when raw materials are extracted, developed, or cultivated for human ends (Laitos et al., 2006). Returns from direct use can be measured rather easily through market activity, such as price and quantity sold, or other financial models. For example, the value of timber harvesting can be measured when the product is sold. Direct uses may also include "non-consumptive uses," like visiting a national park for wildlife viewing. These values

may be quantified by expenditures made to enjoy an experience. Non-consumptive uses such as recreation are generally thought not to be outwardly destructive, but at large enough levels of use, environmental damage may occur (Millennium Ecosystem Assessment, 2005). Resource use also encompasses "indirect uses" derived from a resource or an ecosystem, such as carbon sequestration, clear air, or clean water. Indirect uses can provide life-giving services and functions to this planet (including its humans) when humans do not directly use the resource (Ruhl, Kraft, and Lant, 2007). The value of indirect uses may be measured a number of different ways, which are not discussed in depth at this time. For example, hedonic modeling teases the value of an environmental good, such as a scenic view, out of the data through statistical regression. The value of trees in home landscaping, for example, can be found by comparing the prices of homes with trees to similar homes without trees.

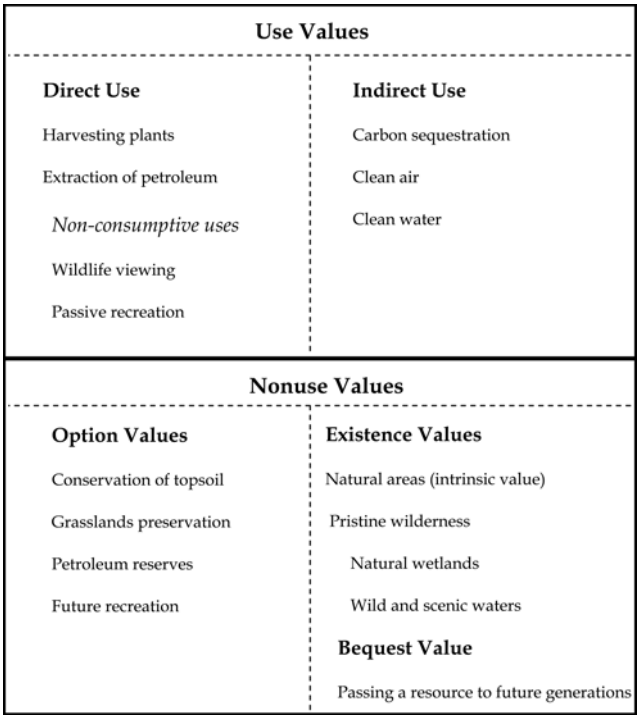


Fig. 2. Use Values and Nonuse Values

In contrast, nonuse benefits arise when humans want to maintain the option of using a resource in the future (otherwise known as "option value"), or preserve a resource for the sake of its existence, otherwise known as "existence value" (Krutilla, 1997).[1] Nonuse values can produce global ecosystem services that permit sustainable life on this earth, even if there are no humans, or if a resource is untouched by humans. Resource nonuse provisions the

[1]There are differences in opinion among economists as to whether "option value" is a sub-category of nonuse or whether it should comprise a third category by itself.

indirect resources that are received and enjoyed by humans (Daily, 1997; Daly and Farley, 2004). People that donate money to save pandas, for example, provide a measure of value for something that they want to have the option to see later, or perhaps will never have a chance to see. A final category of non-use value is the bequest value, when an individual places value on a resource with the hope that the resource will be enjoyed by future generations.

Economists use a number of techniques to quantify nonuse values. Nonuse values are frequently added to the direct use values to determine a more complete picture of the economic value of a natural resource. In this chapter, a specific type of economic modeling, contingent valuation methodology, is presented as an example of a method that can be used to determine the value that visitors place on high mountain recreation experiences and mountain ecosystems.

Contingent valuation can be used to determine the economic value of a resource when there is not a market available to provide price and sales data. Contingent valuation methodology enables researchers to determine the value that individuals would be willing to pay to protect (or even access) a resource in addition to the amount of money that the individual has already paid. This willingness to pay (WTP) is defined by economists as "consumer surplus". When a proper sample size is obtained, economists can determine the average WTP, or average consumer surplus for that particular resource, and use this information as a measure of "economic value". Like all methods, contingent valuation has its limitations. For example, contingent valuation measures what an individual states that he or she is willing to pay (rather than what he or she actually does pay). However, contingent valuation methodology is a generally accepted method for valuing environmental goods, particularly when there is not a market for that good. Much of this chapter reflects use of contingent valuation methodology in generating average consumer surplus for recreation in high alpine mountain ecosystems of the state of Colorado, in the western United States. Values obtained from contingent valuation studies of high mountain peaks reflect the value that hikers and recreators place on their mountain experience, in addition to what they have already spend. Both the expenditure and the consumer surplus data inform policy makers about trade-offs that are made between environmental protection and economic development in these high alpine regions.

4. Case study region and challenges to sustainable economic development

The case study area consisted of two rural counties in central Colorado, USA, Park County (population 17,004) and Lake County (Population 7,913). These counties are home to the two highest elevation incorporated towns in the U.S., Alma (Elevation 10,578 feet) and Leadville (Elevation 10,152 feet), respectively, located 120 and 65 miles (193 km and 105 km) from Denver, the state's population center. While the exact number of visitors to the study area is difficult to ascertain, the recreation and tourism industry is substantial in Colorado, and some inferences may be made about the study region. A 2009 study estimates the state attracted 27.4 million overnight and 23.2 million day visitors (80% from originating from within the state) during 2008, spending a total of $10.9 billion (Longwoods International, 2009). Since more than half the state's population is located within the Denver Metropolitan area, there is a proclivity for the Leadville and Alma study region to attract a large number of day trippers. The close proximity to several well-established ski resorts, including Vail and Breckenridge, put the study area in short reach for side trips from what are often considered major destinations.

The impact of mountain-related recreation in these two communities, shown in Figure 3 was tested in both 2006 and 2009. These communities were identified for the study because they reflect economies in transition from traditional extraction to heritage and recreation-based economies. In essence, both communities are in the process of setting goals for sustainable economic development, and are reflecting how to balance the recreational industry with their mining and extraction heritage in a sustainable manner. For example, the Park County government has been proactive in obtaining a National Heritage Area designation for parts of the region by offering tours of old mine sites and historic ranches.

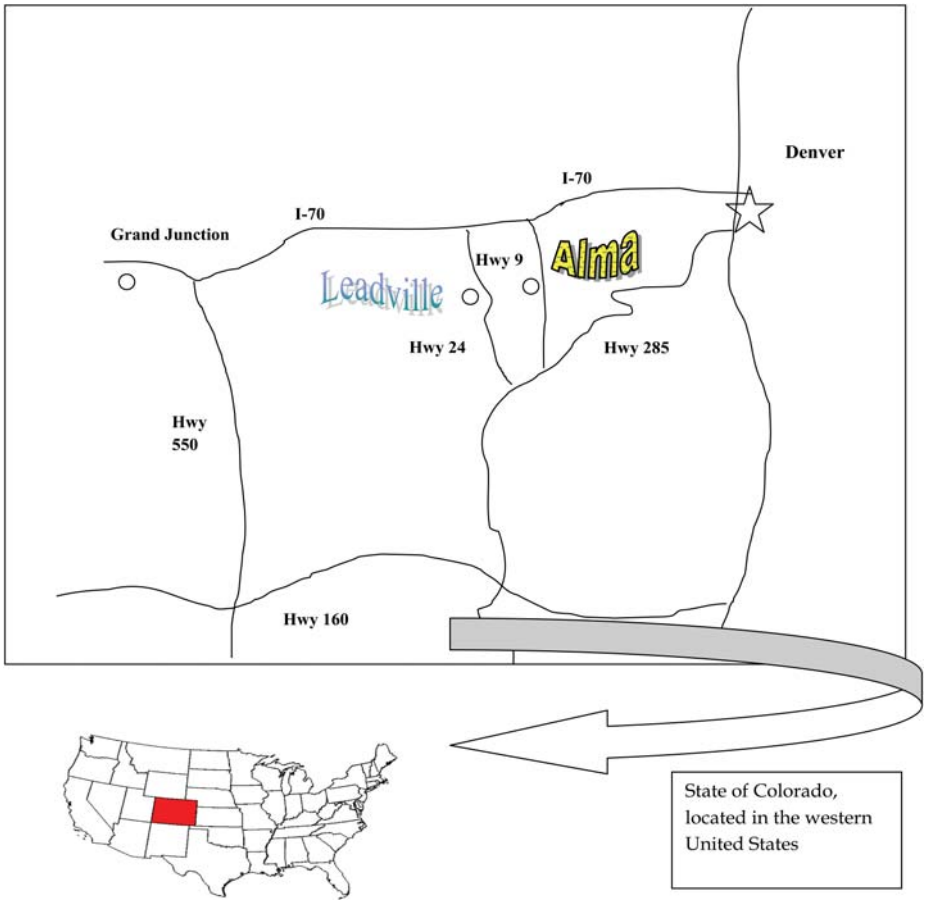


Fig. 3. Map of Study Area

Both Park and Lake Counties also provide unique high alpine recreation experiences, most notably associated with the presence of Colorado "Fourteeners", peaks which rise above 14,000 feet in elevation. There are 54 Fourteeners in the state of Colorado. Outside of Colorado, the states of Alaska, California, and Washington have one or more 14,000 foot peaks, but the majority of the Fourteeners are in Colorado. The valuation studies of the high mountain recreation experience on Fourteeners indicate that these rural communities receive a large economic boost from the visits. While exact numbers for recreational visitor

use can be challenging to obtain (English et al., 2002), data collected by the USDA Forest Service and affiliate groups allow us to estimate that a minimum of 100,000 people from within the state and all across the country specifically seek recreation at Colorado Fourteeners each year (Colorado Fourteeners Initiative, 2007; Frazier, 2006; Kedrowski, 2006). Fourteener recreation activities include day hiking, camping, off road vehicle trails, wildlife viewing and photography opportunities. Other government data support the notion that visitors continue to visit public lands at a similar rate during times of economic decline and economic prosperity. For example, according to National Park Service data, visitors to Rocky Mountain National Park in 2009 numbered roughly 3 million, which is a stable visitation rate since 1991 (Magill, 2010).

However, environmental damage may also result from crowding (particularly on weekend days) and the high value and demand for the recreation experience. In a systematic study that documents environmental damage on Fourteeners, Kedrowski (2006) found that popular Fourteeners have wider trails to accommodate high hiker volume, and more switchbacks were needed to reduce damage due to soil erosion. The ecological damage also presents temporal considerations, as damage to alpine tundra environments often requires decades to regenerate (Summer, 1980; Summer, 1986; McQuaid-Cook, 1978). Similar problems have been noted in climbing areas of the United Kingdom (Hanley, et al., 2003).

At low levels of use, the publicly owned peaks are non-rivalrous and non-exclusive. However, at high levels of use, such as weekends and holidays, these peaks become "congestible public goods". Congestible public goods are often considered public goods with a consumption externality. That is, there is over-consumption of the goods because consumers ignore the external costs that they impose on each other and on the environment (Weimer and Vining, 1999). In this case, crowding reduces the experience for everyone. Unlike a privately provided market good where increased use brings about increased revenues to maintain the resource, most publicly owned Fourteeners lack access fees, thus compounding over-use and under-funding for trail restoration.[2] While most of the 54 Fourteeners fall on public property, approximately 10 Fourteeners are at least partially privately owned, including a few cases of a split mineral estate, where the surface owner is separate from the sub-surface owner, who may own mineral or energy rights. This distinction between the public and private lands has an interesting affect on environmental quality. Culebra Peak, one Fourteener which is entirely privately owned, requires an entrance fee for access. Thus, it is not surprising that it has one of the most pristine environments, according to the Kedrowski study.

To put the congestible public good in perspective, Figure 4 illustrates a long line of recreators hiking up Mount Bierstadt, located approximately 20 kilometers west of Alma. This photo, taken on a weekend morning, is a reflection of the typical weekend foot traffic, and that solitude is not necessarily part of the Fourteener experience. Figure 5 is a photo of a trail on Mount Elbert, which is approximately 25 kilometers south of Leadville and is the highest summit in Colorado. Figure 5 documents trail widening and erosion which result from Fourteener hiking. Findings in the next section indicate that individuals place much

[2] There is evidence that the USDA Forest Service may begin charging access fees at popular Fourteener trailheads for trail management. At this writing, the San Carlos Ranger District, which manages the Pike & San Isabel National Forests, has proposed an access fee to the South Colony Basin. The proposed fee area pertains to access to at least three Fourteeners, although the South Colony Basin is not in the current study area presented in this chapter. The fee proposal is currently under the public comment period. http://www.fs.fed.us/r2/psicc/sanc/

higher value on their high alpine Fourteener recreation experience compared to a "typical" hiking experience, and may be unwilling to substitute their Fourteener recreation. This may lead to considerable environmental and policy making challenges.

Fig. 4. Illustrates the high volume of hikers climbing Mount Bierstadt, a Fourteener, approximately 20 km east of the community of Alma. As can be seen, Fourteener climbing can be more of a social experience than a solitary one. Photo courtesy of Kelly Loomis.

Fig. 5. below, is the photo of a trail from Mount Elbert, located 10km south of the town of Leadville. This particular trail illustrates widening and erosion due to high visitor use. Photo courtesy of Loretta McEllhiney of the USDA Forest Service, Leadville Ranger District.

5. Economic values of high mountain recreation

5.1 Expenditure data and willingness to pay during times of economic expansion versus times of economic recession

This section compares an economic valuation of high alpine Fourteeners, conducted in summer 2006, when the U.S. economy was at its peak to an economic valuation conducted

during 2009 when the economy was considerably depressed. This comparison provides some perspective about how income from recreation compares to other financial sectors when the economy is depressed. In addition to declines in consumer confidence in 2009, the U.S. GDP declined four consecutive quarters during 2008-2009, marking the longest U.S. recession in 60 years (Bureau of Economic Analysis, 2009). Some writers have dubbed this recession the "Great Recession," attempting to draw parallels with the Great Depression of the 1930's (Isidore, 2009). Obviously, a recession means that economic prosperity is diminished, but the results from Keske and Loomis (2007) and Loomis and Keske (2007) indicate that recreators will continue to place high value on their mountain recreation experience, in spite of the decline in economic conditions. That is, recreation may be more recession proof than other economic sectors. In order to assess the value that recreators contribute to the economic development of the study region, the following hypotheses were tested:

1. Do visitor expenditures change before and after the recession?
   Ho: $Expend_{i2006} = Expend_{i2009}$ vs. Ha: $Expend_{i2006} \neq Expend_{i2009}$
2. Does visitor willingness to pay (WTP) change before and after the recession?
   Ho: Mean WTP_{2006}= Mean WTP_{2009} vs. Ha: Mean $WTP_{2006} \neq$ Mean WTP_{2009}

Sampling for both 2006 and 2009 was conducted at Quandary Peak, a recreation area that is southwest of Denver, Colorado. Quandary Peak is approximately 15 kilometers miles directly south of the resort town of Breckenridge, and 10 kilometers north of Alma. A photo of Quandary Peak is presented in Figure 6. In 2006, surveys were distributed over three days, on two separate non-holiday weekends during August and September 2006. The mail back survey booklet was designed in accordance with Dillman's Tailored Design Method (Dillman, 2000). The 2006 mail back surveys were distributed by two volunteers trained on survey distribution procedures. Hikers were approached at trailheads and in parking lots at the conclusion of their recreation activity. There were no refusals to take the survey in 2006. After providing the visitors with the survey and a postage paid return envelope, names and addresses were also collected so that a second survey could be mailed to non-respondents. Of the 199 mail back surveys handed out, 129 surveys were returned, for a response rate of 65%. Based on a comparison of group sizes from our survey data collected during these three weekend days to group sizes from U.S. Forest Service data collected by a non-government organization during the majority of weekends, it appears as though the 2006 data was representative of the summer season.

Fig. 6. Quandary Peak, located 15 km north of Alma, Colorado, Leadville Ranger District. Photo courtesy of Loretta McEllhiney of the USDA Forest Service.

The 2009 data collection process, including trailhead location and survey distribution procedures, mirrored the 2006 data collection process. In 2009, two individuals were trained in the distribution of surveys: a graduate student, and one of the same volunteers instrumental in the distribution of the surveys in the 2006 study. As with the 2006 study, visitors were provided with the mail back survey and a postage paid return envelope. Three weeks later, replacement surveys were mailed to non-respondents. A total of 345 surveys were distributed over five weekend days during July and August, 2009. A total of 248 surveys were returned for a response rate of 72%.

The survey included separate sections, described as follows:

Information regarding the specific trip: Seven questions regarding trip purpose and recreational activities.

Trip expenditures: Five questions addressing trip expenditures on the trip in Colorado. Respondents were asked to report the amount that they and members of their parties (e.g., family, companions) spent in each category. To put expenditures on a per visitor basis, these expenditures were divided by the number of people in the group. Asking for expenditures from the entire party and then dividing by group size is the preferred approach to avoid overestimating per person expenditures (Stynes and White, 2006).

Dichotomous Choice Contingent Valuation Question. *The WTP question was: As you know, some of the costs of travel such as gasoline, campgrounds, and hotels often increase. If the* ***total cost*** *of this most recent trip to the recreation area where you were contacted had been $X* ***higher****, would you have made this trip to* ***this*** *Fourteener?*

Circle one: YES NO

The $X bid amount had values ranging from $2 to $950, randomly varied across all surveys distributed.

There was no statistical difference between visitor expenditures in 2006 and 2009 at the 5% level of significance, with the exception of gasoline purchases which is significantly different at the 10% level. The decreased expenditures on gasoline may be attributable to the fact that visitors, on average, traveled fewer miles to the recreation site in 2009 compared to 2006. Therefore, Fourteener recreation was unaffected by the recession. This is summarized in Table 1, and presented in 2007 dollars to correct for inflation.

We fail to reject the null hypothesis that visitor expenditures were the same in 2006 and in 2009.

Category	2006 Mean	2009 Mean	T-Statistic (P-value)
Miles Driven	264	214	1.12 (.267)
Gasoline Purchases	$61.04	$42.00	1.69 (.092)
Retail Supplies	$13.24	$15.85	-.363 (.717)
Equipment Purchases	$25.14	$28.28	-.441 (.659)
Hotel	$81.62	$129.40	-1.29 (.196)
Food in Restaurants	$78.32	$80.48	-.401 (.689)

Table 1. Comparison of 2006 and 2009 Per Trip Hiker Expenditures in Colorado ($2007)

Longitudinal USFS data indicate that visitor use did not decline between 2006 and 2009. Data reveal that, if anything, visitor use increased from 2006 to 2009. In 2006, 121 contacts were made over 2 non-holiday weekend days, (for an average of 60.5 climbers observed per day). Expanding and projecting this data over 32 non-holiday weekend days from June to

September (optimal Fourteener climbing months, due to weather), the estimated weekend use data were roughly 1,932 visitors. In 2009, there was reported contact with 500 recreators over 6 days, for an average of 83.3 climbers observed per day, or 2,666 visitors over 32 non-holiday weeks. These observations show an increase in visitor contacts, compared to 2006. These numbers are also consistent with our sampling frame, which showed a consistent distribution of approximately 65 surveys per day for 2006 and 2009.

5.2 Contingent valuation (WTP) test results

Table 2 presents the WTP estimates obtained from the 2006 data and the 2009 data to calculate mean WTP and the associated 90% confidence intervals. In 2006 dollars, the mean WTP per person per trip in 2009 is $139 which is 9% below the WTP per person in 2006 ($152). However, as shown in Table 3, the 90% confidence intervals in 2006 overlap the mean WTP in 2009 and vice versa. This indicates there is no statistical difference between the WTP per person per trip in 2006 and 2009. This is further illustrated in Figure 7, which demonstrates no significant different in the mean willingness to pay, and the overlapping confidence intervals. Thus we fail to reject the null hypothesis of no difference in mean WTP between the two time periods. This implies that visitors place the same value on their recreation experience when the economy is struggling, in general, compared to times when the economy is doing well.

	Mean WTP	90% Lower CI	90% Upper CI
2006 data	$152	$123	$190
2009 data	$139	$119	$167

Table 2. Mean Willingness To Pay, Per Person Per Trip, and 90% Confidence Intervals

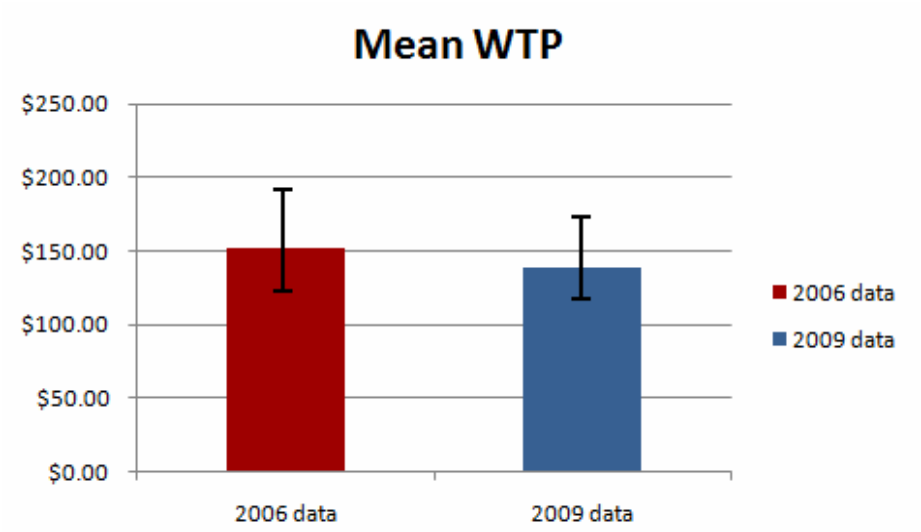


Fig. 7. Illustrating results from contingent valuation modelling, and the non-overlapping confidence intervals in 2006 and 2009. This indicates that recreators have a similar consumer surplus between 2006 and 2009.

The seemingly "recession proof" nature of high mountain recreation reveals that visitors expend as much money during hard economic times as they are willing to spend during vibrant economic times, and that they are willing to spend even more. The values that recreators place on high alpine recreation, by comparison, is more than that of other hiking and rock climbing studies. Several rock climbing studies serve as comparison, including one in Colorado by Ekstrand (1994). He asked rock climbers at Eldorado Canyon outside of Boulder, Colorado what they would pay to do similar climbs but at remote wilderness locations. His value of $27.95 per day in 1991 is equivalent to $40 when adjusting for inflation to 2006. Grijalva and Berrens (2003) estimated a value of rock climbing in Texas at between $47 and $56 per day trip. More comparable to our study is the study by Grijalva, et al. (2002) that involves climbing in USDA U.S. Forest Service designated wilderness areas. These authors found a WTP of only $20 to $25 per person to avoid closing several climbing sites in several National Forest, National Park and Bureau of Land Management (BLM) Wilderness areas. Using a count data model for climbing in the Italian Alps, Scarpa, Tempesta, and Thiene (2003) estimated (in Euros, which have been converted to dollars), consumer surplus of $23 to $38 per day trip. However, Scarpa, et al. (2003: 118), notes that their consumer surplus figures are probably underestimates due to not accounting for travel time in the travel cost variable.

It is believed that the remarkably high consumer surplus can be attributed to the fact that Fourteeners are considered "special" environmental icons that provide place attachment to Colorado visitors and tourists alike. There are no close substitutes. Place attachment theory, developed in sociology (Cross, 2001), environmental psychology (Kyle et al., 2004), and geography(Manzo and Perkins, 2006), postulates that there can be a psychological connection between a community and a natural resource. Research by Blake (1999, 2002, 2008) suggests that Fourteeners are synonymous with Colorado's identity, and that Fourteener references are ubiquitous—appearing on everything from Chamber of Commerce information and local festivals to print advertisements and postcards. Blake (2002) indicates that more easily recognizable Fourteeners such as Long's Peak in Rocky Mountain National Park and Pikes Peak in Colorado Springs also provide a state identity. Thus, our economic findings are consistent with other disciplines that have recognized that there is something unique about both specific and the collection of Fourteeners, and in the minds of some visitors, there may not be substitution between peaks.

This yields concerns for environmental sustainability for high alpine soils and vegetation. Visitors have already demonstrated that they are willing to pay a relatively high amount of money to hike these high alpine peaks, and further research validates that visitors may not be willing to substitute to these high mountain ecosystems, even with substantial cost increases. This seemingly inelastic demand for high mountain recreation brings interesting management implications needed to reduce visitor use to levels that are necessary for achieving environmental targets.

5.3 Visitor willingness to substitute high alpine experiences

An expanded study of the Colorado Fourteener project examined the willingness for hikers to substitute their recreation experience. During the summers of 2006 and 2007 a total of 939 surveys were distributed to hikers visiting a stratified sample of Fourteener peaks throughout Colorado. Approximately half the surveys were distributed at several of the popular Fourteeners along or nearby the Front Range dominated by Denver, Colorado Springs and the peaks nearby several resort towns (e.g., Breckenridge and Aspen). There

were 18 refusals to take the survey, all of which took place at the Maroon Bells in Aspen. After providing the visitors with the Fourteener survey and a postage paid return envelope, volunteers collected follow-up information for the second round of survey distribution to follow Dillman's (2000) repeat mailing recommendation. In total 560 surveys have been returned, for a response rate of 60%. The primary valuation question was:

1a. As you know, some of the costs of travel such as gasoline, campgrounds, and hotels often increase. If the total cost of this most recent trip to the recreation area where you were contacted had been $X higher, would you have made this trip to this Fourteener?

Circle one: YES NO

The $X bid amount had values ranging from $2 to $950. In order to ascertain if hikers would switch to another Fourteener to avoid the increase in cost, hikers were asked:

1b. If the total cost of this most recent trip to the recreation area where you were contacted had been $_____ higher, would you have made this trip to a different Fourteener where you would not have these higher costs?

Circle one: YES NO

In order to ascertain if hikers would switch to a lower elevation Thirteener to avoid the increase in cost, hikers were asked:

1c. If the total cost of this most recent trip to the recreation area where you were contacted had been $_____ higher, would you have made this trip to a Thirteener (one of Colorado's 13,000 foot summits) where you would not have these higher costs?

Circle one: YES NO

The three-part dichotomous choice contingent valuation survey questions were presented separately, and were not made contingent upon the answer to the first question. The rationale behind this decision was based upon feedback provided by USDA Forest Service wilderness managers and non-profit organizations like the Colorado Mountain Club and the Colorado Fourteeners Initiative, whose qualitative research revealed that there would be different patterns of substitutability in Fourteener hikers. In summary, the field research conducted by these organizations revealed that there were people who were simply drawn to hike or climb a single Fourteener, or simply a high peak, like a Thirteener (and it often doesn't matter which Thirteener they hike). However, there were other hikers for whom there were no substitutes. These three questions were designed to detect whether there were substitutes for the Fourteener at which the subject was contacted.

In order to classify visitors that would and would not substitute for their current Fourteener, the response patterns to questions 1a, 1b and 1c were analyzed and grouped as follows:

Group One: Visitors who would not substitute another Fourteener or Thirteener:

This group consists of two types of response patterns: 44% of the total respondents said YES they would pay more for their current Fourteener (1a=YES), and NO to avoiding the increase in cost by visiting a different Fourteener (1b=NO) and/or a Thirteener (1c=NO). A second category of visitors who did not indicate willingness to substitute are those that said NO to paying the increase (1a=NO) not only at their current Fourteener, but also NO at the substitute Fourteener (1b=NO) and Thirteener (1c=NO). This response pattern indicated to us that if they could not go to their current Fourteener, they did not want to go a different Fourteener or Thirteener either (i.e., they would stay home or do something quite different). This second category represented about 16% of the total sample. Thus, approximately 60% of the total visitors reported no substitutes to their current Fourteener at the bid amount they were asked to pay.

Group 2: Visitors who would substitute another Fourteener or Thirteener:
This group also consists of two categories of respondents with a willingness to substitute as follows: The first category consisted of visitors who stated NO to question 1a on willingness to pay the increase cost for their current Fourteener, and YES on 1b and/or 1c to avoid the cost increase and therefore visit a different Fourteener or a Thirteener. This represented about 27% of the sample. However, the substitution group also included some visitors who initially said they would pay the cost increase to visit their current Fourteener, but then indicated they would switch to another Fourteener (YES on question 1b) or a Thirteener (YES on question 1c) to avoid the cost increase with visiting their current Fourteener (13% of the sample). Thus, overall the substitution group represents about 40% of the total visitors.
Table 3 summarizes the mean WTP and 90% confidence intervals for the Substitute Group and the No Substitute Group. The $294 mean trip value for those not willing to substitute another Fourteener is more than triple the $88 trip value for those willing to substitute another Fourteener or Thirteener. This suggests substantial differences in valuations. As can be seen in Table 3, the 90% confidence intervals do not overlap suggesting that these mean WTP amounts are statistically different (the same is true of the 95% confidence intervals, not shown).

Group	Substitute Group	No Substitute Group
Mean	$88	$294
Upper 90% CI	$122	$397
Lower 90% CI	$67	$232

Table 3. Mean WTP per person per trip and 90% Confidence Intervals (CI)

It should be noted that no questions were asked in the survey booklet inquiring whether consistent refusals to pay the bid amount were protests to some feature of our constructed market. However, we systematically reviewed the written comments visitors were encouraged to write on the back of the survey for indication of protest responses to the WTP question. In the first review phase, the qualitative data (entered by ID number), were reviewed for potential protest information. If the comments indicated a potential protest, then the responses to the three contingent valuation questions were examined. Based upon review of the written comments, approximately 17 responses were categorized as having the potential to be protest responses. The majority of these respondents wrote on either the importance of maintaining public access to Fourteeners, the potential for environmental damage due to crowding, or the effect of crowds on their "natural" experience. Interestingly, responses to the contingent valuation questions for these individuals were distributed fairly evenly, and there were not indications of response bias or protest responses in these 17 responses.
In the second phase of the protest investigation, surveys were screened for individuals who answered "no" to all three dichotomous choice WTP questions in order to examine whether there were any qualitative patterns to their responses. Unfortunately, the majority of these individuals did not provide an explanation for their responses. However, a general review of all written comments indicates that a majority of respondents that did comment focused on the effect of increased costs on their willingness to either substitute (or to not substitute) to other locations. This indicated that respondents understood the WTP questions, and answered accordingly to their preference of whether to substitute.

Clearly, there is a rather large number of individuals for whom there appears to be no substitutes for their high mountain alpine recreation experience. Based on statistical analysis of responses of Fourteener recreationists, it was determined that there were two statistically different groups of hikers. A logistical regression was tested on the effects of charging a $70 entrance fee to reduce use:

a. The first group consists of dedicated recreators. 89% will pay a $70 fee rather than substitute. Using a dichotomous choice contingent valuation question, the consumer surplus or net WTP of this group was $294 with a 90% confidence interval of $232-$397.
b. The second group are more casual recreators that are likely to substitute to another Fourteener or lower elevation Thirteener to avoid a cost increase at their current Fourteener. This group has a consumer surplus of $88, with a 90% confidence interval of $67-$122. This group would reduce their use of the current Fourteener by 40% at a $70 fee.

Separate WTP curves were estimated for dedicated and casual recreators to quantify the rate at which each would substitute other peaks for the Fourteener where they were intercepted. This was done by estimating separate logit regression models for each of these two groups in order to determine their WTP for the current Fourteener and to allow for a likelihood ratio test to determine if their logit coefficients are statistically different. The separate logit regressions allowed for calculating separate logit WTP curves, illustrating the relationship between the percentages of each type of visitor that would pay different fee increases (Figure 8).

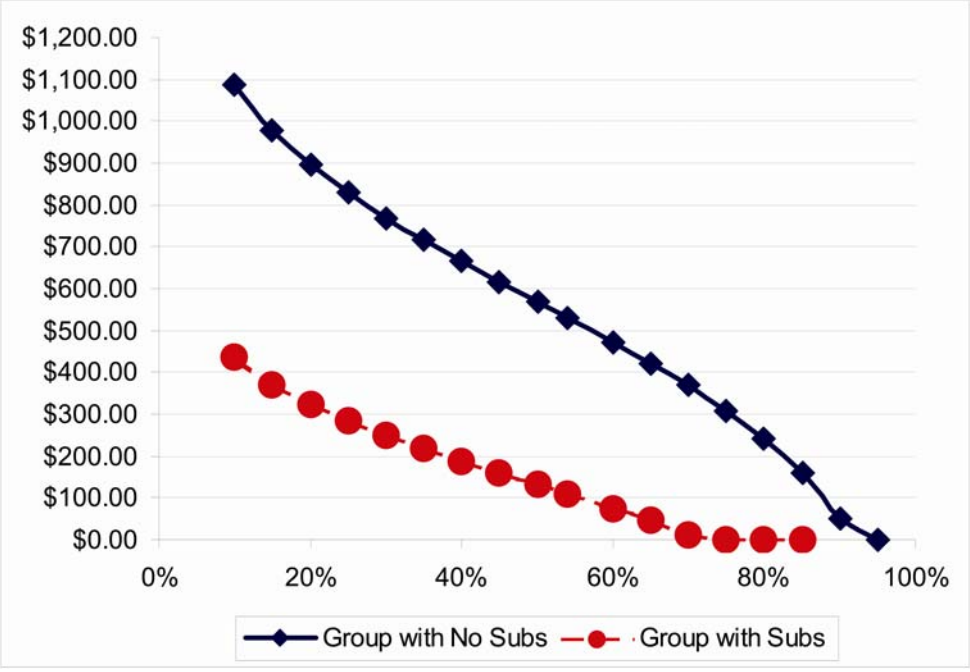


Fig. 8. Logit WTP Curves for No Substitute Group and the Substitute Group

Given that 60% of the hikers were dedicated, and 40% of hikers were casual, a $70 fee would result in an overall 22% reduction in visitor use to the current Fourteeners. This magnitude of reduction in visitor use may be sufficient to reduce the rate of trail erosion and loss of vegetation so as to stabilize the alpine environment surrounding these peaks. Also, the funding provided by the $70 fee could yield substantial revenue for replacement of the multiple social trails scarring the many popular Fourteeners with a single carefully located and maintained trail. While precise estimates of Fourteener use are not available, the public land management agency and volunteer groups estimate roughly 100,000 Fourteener visitors per year. Given the 22% reduction in use with the $70 fee, the remaining 78% of visitors paying the $70 fee would produce $5.4 million revenue if the fee was applied per person or $2.73 million if the fee was charged per vehicle, as the National Park Service does. Taken together, the reduction in use, and funding for better management could allow for more sustainable visitor use, and the avoidance of the need to impose daily quotas or caps on visitor use.

Although the findings indicate that introduction of fees at public Fourteeners may have desired effects on Fourteener use, practical implementation of the policy is another matter. There was not a clear pattern of protest responses in our survey; more than one dozen respondents provided written comments on the need to maintain unrestricted access to Fourteeners. Interestingly, these comments were counter balanced by individuals who also urged a small fee to enhance trail maintenance and to mitigate environmental damage, including damage due to crowding. Although those "tuned in" to the issue of access fees may represent a minority, it is evident from blogs and USDA Forest Service qualitative studies that this group is likely to present fierce opposition to such a policy.

6. Community preferences for use of high mountain ecosystems

Results of the expenditure and contingent valuation studies on Colorado's high mountain peaks indicate that there are significant economic development opportunities stemming from the mountain ecosystems. However, as noted by the MA report, the connection between natural ecosystems and cultural ecosystem services such as recreation and aesthetics is an important part of sustainability. Thus, as part of this project, community preferences for recreation and ecosystem management were also assessed as part of two stakeholder meetings within the case study region in order to determine the cultural fit and community preferences for high mountain recreation.

6.1 Stakeholder meetings

Meetings were held on two consecutive weekdays in the respective communities, at centrally located, established community meeting halls, the Alma Town Hall and the Leadville Mining Museum. In order to generate support for the meetings, community flyers were posted in local businesses, ads were posted in the respective newspapers, e-mails were distributed to key public officials such as the mayor's office and the county commissioners. Community meetings also were advertised by word of mouth, which was revealed to be a common and effective means of information transfer in these rural communities.

The 90-minute stakeholder meetings were organized into four parts The first 10-minutes allowed for introductions and a review of the project objectives and phases, including future

community-level surveys and soils field work to evaluate the carrying capacity of recreational lands. The overview was presented by the lead project investigator, who provided insight into how the results would be integrated into future study phases. The introduction was limited to 10 minutes, in order to balance the objectives of obtaining stakeholder input, ensure adequate attendance, and facilitate an efficient meeting. The introductions were followed by a brief question and answer session to ensure that participants understood the purpose of the study and their own role in providing valuable information. Despite the limited introduction time, all stakeholders were introduced to project investigators prior to the beginning of the stakeholder meeting and had ample opportunity to have questions addressed following the meeting.

This study implemented an alternative design for a public meeting to facilitate public involvement. The introductions were followed by a 50-minute session where the stakeholders presented input, and reviewed instantaneous results, using an Audience Response System (ARS) system. ARS was used in a public forum to facilitate more efficient information exchange among citizen stakeholders and promote critical thinking and dialogue. The ARS technology enabled stakeholders to reveal their preferences anonymously in a group setting, thereby providing information to the entire group in real time (Keske and Smutko, 2010).

ARS technologies that actively poll participants and show immediate responses have been in existence for decades. Declining costs for such systems during the past ten years have made the technology affordable for university, as well as primary and secondary educational settings (Banks, 2006). Recent technological advancements have also improved transportability and ease of use. There are several ARS systems currently available.

Most commercial systems consist of three components: a receiver, software, and hand-held transmitters ("the clickers"). Most systems utilize a small, wireless receiver that plugs into the facilitator's USB computer port. The facilitator polls the audience with a set of pre-determined questions, which can be projected onto a large screen using a computer with Microsoft Office-compatible software and projector. Respondents transmit their answers with the small, lightweight, hand-held remote controlled clickers, and results are shown immediately after the brief (usually 15-45 seconds) polling period. The facilitator can choose to present the results in numerous ways. For example, polling may be active, which allows respondents to observe (and therefore become influenced by) the votes and decisions of others while they are still deciding how to vote. Another option is for the facilitator to cast a "revote" after more information is provided in order to measure the change in response.

Two ARS practice questions were instituted to ensure that stakeholders were comfortable with the system. After the ARS voting, there were 20-minutes of small group discussion, where participants provided validation to the responses, and elaborated upon other key issues that emerged during the ARS presentations. The last 10 minutes were spent on the stakeholder meeting evaluations. Both communities received information about the other stakeholder events. Results were also disseminated through the local newspapers, *The Fairplay Flume* and the *Leadville Herald Democrat*, by journalists who attended the meetings. Further validity was provided by comparing ARS results from the Region 8 United States Environmental Protection Agency, who followed up our results with Internet surveys and a "Virtual Forum" chat room (United States Environmental Protection Agency, 2010).

6.2 Results

ARS results for each of the stakeholder meetings are presented in Table 4. The results are arranged according to each of the three themes (trade offs, distribution of costs and benefits, and cultural fit), with the response percentages rounded to the closest whole number. Participants also reflected long-term residents, and statistics were nearly identical for both communities. More than 20% of participants resided in the community between 5-10 years. More than 55% of residents resided in the community greater than 10 years. The majority (72%) of Leadville attendees actually worked in Leadville. In contrast, not quite half of the Alma attendees reported working within the county.

Stakeholders in both communities expressed that they felt that traditional Old West industries could co-exist with recreation and heritage economic development in their communities to some extent. 75% of the Park County stakeholders agreed with the statement that "an expanded heritage and recreation economy will have a positive impact on our existing farm and ranch enterprises", while the remaining 25% believed that there would be no effect. By way of explanation, during the break-out sessions, several attendees felt that Park County was already successful in encouraging agri-tourism, and that it should continue on this path. With high elevation ranching far more prevalent in the meadows of the Park County, Lake County residents were asked: "What would be the most important thing that could be done to make the Mineral Belt Trail biking trail a keystone attraction for Leadville?" There was high amount of variation in the responses, with the majority (54%) preferring to emphasize the Mineral Belt Trail as a biking destination, 29% of the respondents preferring to highlight the Trail's historic mining aspects, and 17% wishing to improve the retail and concession opportunities.

There was an interesting difference in the community attitudes towards extraction. Almost exactly one-third of the Alma residents felt that mining could not coexist in a recreation and heritage economy and one-third felt that mining would compromise heritage and recreation tourism. One-third of Alma residents felt that the mining and heritage/recreation economic sectors could coexist. In Leadville, where the reopening of a mine may be a possibility in the near future, the numbers were almost exactly reversed. Two-thirds of the Lake County residents felt that "Mining can coexist very well with an expanded heritage and recreation economy", while 25% felt that there would be trade offs between the two sectors. Only 9% of Lake County residents felt that "mining is not at all compatible with an expanded heritage and recreation economy."

In contrast, responses to other trade off questions were similar for the communities. While the questions were worded slightly differently, approximately 75% of respondents expressed that there would be positive benefits to their land and community from a transition to a recreation and heritage economy. Another similarity is that a majority of residents of both communities felt that their safety would remain unaffected by an increase in heritage and recreation economic development; however, a considerable number (45% in Alma and 23% in Leadville) believed that their safety would decrease, citing recent murders at remote mountain recreation sites.

Stakeholders were generally optimistic that benefits from an expanded heritage and recreation economy would accrue to local residents, both financially and in other ways. When asked whether an expanded heritage and recreation economy would bring more jobs for local residents, 92% of Lake County respondents, and 74% of Park County respondents

agreed with that statement. Although most respondents believed more jobs would result, more than half – 60% in Lake County and 52% in Park County – thought that overall incomes in their respective counties would remain the same. This perceived separation of job numbers from total income may stem from a belief voiced among some stakeholders at the two meetings that wages in the tourism industry are generally lower than wages in other economic sectors.

Respondents in Lake County overall were more positive than Park County respondents about the potential financial benefits of heritage and nature-based tourism. When asked if they would realize personal financial gain from an expanded heritage and recreation economy, 69% of Lake County respondents indicated that they would be much better off or slightly better off financially compared to only 39% in Park County. However, perceptions of non-financial benefits resulting from heritage- and nature-based tourism were more evenly matched between the two counties. When asked if they would gain more than just financial benefits from an expanded heritage and recreation economy, 88% of meeting participants from Park County agreed or strongly agreed with that statement compared to 78% of respondents from Lake County.

Differences between the two counties with respect to expectations for financial gain may be a reflection of the differences in meeting participants' employment and occupation status. Nearly 43% of the people attending the Lake County meeting were employed in the retail/service or building/utility sectors, compared to just 17% of Park County participants. Moreover, 28% of the Park County participants were retired as compared with just over 8% of the Lake County participants.

Commensurate with their optimism about potential financial gains from an expanded heritage and recreation economy, Lake County residents were more sanguine about how wealth and benefits would be spread among county residents. Most (56%) Lake County respondents believed that benefits would be dispersed among a wide range of people in their county, compared to only slightly more than a third (37%) of Park County respondents. Nearly half (48%) of the Park County residents thought that benefits would accrue to a small subset of people in the county, and another 15% believed that outsiders would gain the most. In Lake County, 36% and 8%, respectively, believed that wealth would be accumulated by a small subset of people or outsiders.

The third line of inquiry in the ARS stimulus questions was that of cultural fit. We were interested in learning how stakeholders perceive heritage- and nature-based tourism and tourists with respect to their own sense of cultural identity. Cultural compatibility is an important consideration in developing a tourism economy in a locality for the principal reason that local residents are essentially inviting people into their communities and sharing the experiences and amenities that are important and valuable to them. Cultural fit even blends into perceptions of cultural, economic, and environmental sustainability and the trade offs that must be made to accommodate growth in this economic sector.

We began with a question about the perceived status of the existing tourism infrastructure. We asked participants whether the quality and quantity of motels, restaurants, shops and attractions in each county was sufficient, was somewhat lacking but still could support an expanded heritage and recreation based economy, or was sorely lacking and needed improvement in order to support an expanded heritage and recreation economy. The responses were surprisingly different in each county, despite similarities in the number and

variety of retail services between the communities, and proximity to resort communities. In Park County, 97% of the respondents considered their county's tourism infrastructure to be sufficient or only somewhat lacking. In Lake county, only 54% thought so well of the quality and quantity of their motels, restaurants, shops, and attractions. This is despite the fact that both counties feature approximately an equal number of accommodation and food service establishments. According to 2002 census data (U.S. Census Bureau, 2002), Lake County had 12 hotels, motels and inns and Park County had 15; and Lake County had 27 eating and drinking establishments while Park County had 24. Although these numbers say nothing about the quality of those establishments, both communities' accommodation and food service sectors are comprised almost exclusively of small, locally owned establishments.

Next, we asked stakeholders whether they believed an expanded heritage and recreation economy would be compatible with the lifestyle of their community, would change the lifestyle of their community to some degree, or would have a significant negative effect on the lifestyle of their community. The question was worded differently in each meeting locality. In Lake County we asked the question with respect to Leadville (e.g., compatible with *Leadville's* lifestyle), by far the largest of two incorporated municipalities in the county. All but two Lake County respondents resided in Leadville. For Park County, which contains nine incorporated towns, we phrased the question so that respondents answered with respect to their community of residence (e.g., compatible with *your community's* lifestyle). All Park County respondents were from one of three towns: Alma, Fairplay, or Como.

A total of 68% of Lake County respondents believed that an expanded heritage and recreation economy would be compatible with Leadville's lifestyle, while 27% thought that it would change the lifestyle of Leadville to some degree, and 5% said it would have a significant negative effect. All Lake county respondents agreed or strongly agreed with the statement, "An expanded heritage and recreation economy is a good fit for Leadville." Nearly all (95%) agreed or strongly agreed that expanded heritage- and nature-based tourism would be a good fit for the Twin Lakes area and northern Lake County.

In Park County, respondents were evenly split (48% and 48%, respectively) between the statements that an expanded heritage and recreation economy would be compatible with the lifestyle of their community, or would change the lifestyle of their community to some degree. A small minority (3%) believed that expanding tourism would negatively affect the lifestyle of their community. 96% of respondents believed that an expanded heritage and recreation economy would be a good fit for central Park County (Alma, Fairplay and Como), 88% believed that it would be a good fit for southern Park County (the Lake George, Hartsel area), and a small majority, 52%, felt the same about the cultural fit with eastern Park County (Bailey, Shawnee and Grant).

When we asked stakeholders about the type of heritage and recreation activities that they thought would provide the most economic benefit to their county, answers differed significantly between the two counties. In Lake County, backcountry recreation such as mountain climbing, hiking, and cross-country skiing was considered by most people (59%) to be the most promising economically, followed by heritage and historic tourism, wildlife viewing, and birding at 23%. ATV riding and snowmobiling came in a distant third at 14%. Park County respondents were nearly evenly split among backcountry recreation (34%), heritage and historic tourism (34%), and fishing, hunting and shooting (28%). One Park County participant ranked All-Terrain Vehicle (ATV) and snowmobiling as having the

Theme: Tradeoffs	
Park County	**Lake County**
An expanded heritage and recreation economy in Park County… 1. Will have a positive impact on our existing farm and ranch enterprises **(74%)** 2. Will have no affect on our existing farm and ranch enterprises **(22%)** 3. Will have a negative impact on our existing farm and ranch enterprises **(3%)**	What would be the most important thing that could be done to make the Mineral Belt Trail a keystone attraction for Leadville? 1. Make enhancements to highlight it as an historic mining destination **(29%)** 2. Make enhancements to highlight it as a bicycling destination **(54%)** 3. Make enhancements to include more retail, restaurants and lodging **(17%)**
If mining were to make a comeback in Park County… 1. Mining can coexist very well with an expanded heritage and recreation economy **(31%)** 2. Mining can coexist with an expanded heritage and recreation economy, but with some losses to tourism and recreation **(34%)** 3. Mining is not at all compatible with an expanded heritage and recreation economy **(34%)**	What is your opinion about mining and a heritage-recreation economy in Lake County… 1. Mining can coexist very well with an expanded heritage and recreation economy **(65%)** 2. Mining can coexist with an expanded heritage and recreation economy, but with some losses to tourism and recreation **(26%)** 3. Mining is not at all compatible with an expanded heritage and recreation economy **(9%)**
An expanded heritage and recreation economy in Park County will have a negative effect on the land and my community 1. Strongly Agree **(0%)** 2. Agree **(17%)** 3. Disagree **(75%)** 4. Strongly Disagree **(8%)**	An expanded heritage and recreation economy in Lake County will have a positive effect on the land and my community 1. Strongly Agree **(24%)** 2. Agree **(43%)** 3. Disagree **(24%)** 4. Strongly Disagree ((**10%)**
An expanded heritage and recreation economy in Park county will… 1. Make me feel safer **(0%)** 2. Have no effect on how safe I feel **(57%)** 3. Make me feel less safe **(43%)**	An expanded heritage and recreation economy in Lake County will… 1. Make me feel safer **(0%)** 2. Have no effect on how safe I feel **(77%)** 3. Make me feel less safe **(23%)**
	Significant environmental clean up in Lake County is necessary to expand the heritage and recreation economy here 1. Strongly Agree **(25%)** 2. Agree **(17%)** 3. Disagree **(50%)** 4. Strongly Disagree **(8%)**

	An expanded heritage and recreation economy in Lake County will have a positive effect on water quality 1. Strongly Agree **(5%)** 2. Agree **(25%)** 3. Disagree **(70%)** 4. Strongly Disagree **(0%)**
Theme: Distribution of Costs and Benefits	
Park County	**Lake County**
If Park County expands its heritage and recreation economy… 1. There will be more jobs for local residents **(74%)** 2. There will be about the same number of jobs for local residents **(22%)** 3. There will be fewer jobs for local residents **(4%)**	If Lake County expands its heritage and recreation economy… 1. There will be more jobs for local residents **(92%)** 2. There will be about the same number of jobs for local residents **(8%)** 3. There will be fewer jobs for local residents **(0%)**
If Park County expands its heritage and recreation economy… 1. Overall, incomes in the county will increase **(45%)** 2. Overall, incomes in the county will remain about the same **(52%)** 3. Overall, incomes in the county will decrease **(3%)**	If Lake County expands its heritage and recreation economy… 1. Overall, incomes in the county will increase **(40%)** 2. Overall, incomes in the county will remain about the same **(60%)** 3. Overall, incomes in the county will decrease **(0%)**
An expanded heritage and recreation economy in Park County will likely make me: 1. Much better off financially **(4%)** 2. Slightly better off financially **(33%)** 3. Unaffected financially **(59%)** 4. Slightly worse off financially **(0%)** 5. Much worse off financially **(4%)**	An expanded heritage and recreation economy in Lake County will likely make me: 1. Much better off financially **(26%)** 2. Slightly better off financially **(43%)** 3. Unaffected financially **(30%)** 4. Slightly worse off financially **(0%)** 5. Much worse off financially**(0%)**
I would gain more than just financial benefits from an expanded heritage and recreation economy 1. Strongly agree **(21%)** 2. Agree **(57%)** 3. Disagree **(18%)** 4. Strongly disagree **(4%)**	I would gain more than just financial benefits from an expanded heritage and recreation economy 1. Strongly agree **(46%)** 2. Agree **(42%)** 3. Disagree **(13%)** 4. Strongly disagree**(0%)**

If Park County expands its heritage and recreation economy… 1. Benefits will be dispersed among a wide range of people in Park County **(37%)** 2. Benefits will accrue mostly to a small subset of people in Park County **(48%)** 3. Benefits will accrue mostly to outsiders **(15%)**	If Lake County expands its heritage and recreation economy… 1. Benefits will be dispersed among a wide range of people in Lake County **(56%)** 2. Benefits will accrue mostly to a small subset of people in Lake County **(36%)** 3. Benefits will accrue mostly to outsiders **(8%)**
An expanded heritage and recreation economy in Park County will have a negative effect on me 1. Strongly Agree **(0%)** 2. Agree **(18%)** 3. Disagree **(57%)** 4. Strongly Disagree **(25%)**	
Theme: Cultural Fit	
Park County	**Lake County**
The quality and quantity of motels, restaurants, shops and attractions in Park County... 1. Is ready to support an expanded heritage and recreation economy **(45%)** 2. Is somewhat lacking, but there is enough to support an expanded heritage and recreation economy **(52%)** 3. Is sorely lacking and needs to be improved before we can expand a heritage and recreation economy **(3%)**	The quality and quantity of motels, restaurants, shops and attractions in Lake County... 1. Is ready to support an expanded heritage and recreation economy **(9%)** 2. Is somewhat lacking, but there is enough to support an expanded heritage and recreation economy **(45%)** 3. Is sorely lacking and needs to be improved before we can expand a heritage and recreation economy **(45%)**
An expanded heritage and recreation economy in Park County… 1. Will be compatible with the lifestyle of my community **(48%)** 2. Will change the lifestyle of my community to some degree **(48%)** 3. Will have a significant negative effect on the lifestyle of my community (**3%)**	An expanded heritage and recreation economy in Leadville… 1. Will be compatible with Leadville's lifestyle **(68%)** 2. Will change the lifestyle of Leadville to some degree **(27%)** 3. Will have a significant negative effect on the lifestyle of Leadville **(5%)**
An expanded heritage and recreation economy is a good fit for [*name of Park County community*] (3 questions) **Answers varied according to community** 1. Strongly Agree 2. Agree 3. Disagree 4. Strongly Disagree	An expanded heritage and recreation economy is a good fit for [*name of Lake County community*] (3 questions) **Answers varied according to community** 1. Strongly Agree 2. Agree 3. Disagree 4. Strongly Disagree

What type of heritage and recreation activities will provide the most economic benefit to Park County?	What type of heritage and recreation activities will provide the most economic benefit to Lake County?
1. Backcountry recreation such mountain climbing, hiking, x-c skiing, etc. **(34%)** 2. Fishing, hunting, and shooting **(28%)** 3. Heritage and historic tourism, wildlife viewing, birding, etc. **(34%)** 4. RV camping **(0%)** 5. ATV riding and snowmobiling **(3%)**	1. Backcountry recreation such mountain climbing, hiking, x-c skiing, etc. **(59%)** 2. Fishing, hunting, and shooting **(5%)** 3. Heritage and historic tourism, wildlife viewing, birding, etc. **(23%)** 4. RV camping **(0%)** 5. ATV riding and snowmobiling **(14%)**
Which type of people would you most like to attract to Park County? People who… 1. Stay for a day or two, then go back home **(32%)** 2. Stay for a week or two, then go back home **(57%)** 3. Have a second home here and visit regularly **(7%)** 4. Want to settle here **(4%)**	Which type of people would you most like to attract to Lake County? People who… 1. Stay for a day or two, then go back home **(18%)** 2. Stay for a week or two, then go back home **(55%)** 3. Have a second home here and visit regularly **(23%)** 4. Want to settle here **(5%)**
Which type of people would you most like to attract to Park County? People who… 1. Spend most of their time in the back country **(0%)** 2. Split their time between the outdoors and town **(79%)** 3. Spend time at a recreation area or ranch **(10%)** 4. Pass through on a day trip **(10%)**	Which type of people would you most like to attract to Lake County? People who… 1. Spend most of their time in the back country **(0%)** 2. Split their time between the outdoors and town **(95%)** 3. Spend time at a recreation area or ranch **(0%)** 4. Pass through on a day trip **(5%)**

Table 4. Results of Stimulus Questions (Organized by Thematic Category and County) Rural Community Preferences for Extraction and Recreation, Park and Lake Counties, Colorado, USA. Due to rounding, the sum of some values will be slightly greater than or less than 100%.

greatest economic potential. Interestingly, no one from either meeting site ranked Recreational Vehicle (RV) camping as potentially providing the most economic benefit.

When asked about the type of people, in terms of duration of stay, they would most like to attract to their county, most respondents in both counties preferred those would stay for a week or two and then go back home (Lake County = 55%; Park County = 57%). Lake County stakeholders wanted visitors to stay longer (only 18% wanted people who stay a day or two versus 32% in Park County), and were more tolerant of second-homeowners (23% in favor versus 7% in Park County). We were also interested in stakeholder preferences about where visitors should spend time while in the county. Nearly all respondents (95% in Lake County and 79% in Park County) preferred tourists who split their time between the outdoors and in town. No one stated a preference for tourists who spend most of their time in the back country. A small minority of respondents (5% in Lake County and 10% in Park County) most wanted to attract visitors who pass through on a day trip.

7. Conclusions

This chapter reflects upon sustainability issues associated with the delicate, and unique, balance of economic and environmental tradeoffs in high mountain communities. How much recreational love can these ecosystems sustain? Much of this chapter is devoted to definitions of "sustainability" and methods for economic valuation. Economic studies conducted from 2006-2010 indicate that both recreators and residents place high value on the high mountain natural resources and lifestyles, even when compared to other natural experiences. Given the high potential for economic development, community residents and visitors to the region must consider trade-offs between economic drivers and environmental quality. This requires the use of collaborative conservation techniques, which should be accompanied by setting targets for both conservation and economic development.

Findings from an economic valuation study of Colorado's high mountains indicate that visitors are willing to spend significantly more money for a high mountain recreation experience compared to a typical hiking experience, and that there may be an unwillingness to substitute their unique high elevation experiences for other natural experiences. In order to manage these delicate high alpine regions, environmental targets should be created that consider how to manage high volumes of visitor use, particularly in times of peak demand, where crowding may result in trail widening or other environmental damage that may lead to erosion. However, implementation of policies designed to reduce overuse of environmental resources may be difficult. Visitors place a great deal of value on these experiences, and the connection between visitors and these high mountain regions yield questions about income distribution and environmental equity, to ensure that visitors of varied income levels have access to these public lands. Imposing a fee to redirect hikers to using the public lands during off-peak timing may generate considerable resistance among lower income populations.

With regards to sustainable economic development in the high mountain regions, it is important to reflect upon the four pillars of ecosystem services that promote biodiversity and life on earth: supporting, provisioning, regulating, and cultural ecosystem services. From a cultural perspective, evidence from community focus groups in the study region indicates that high mountain recreation is part of the community culture, and extends beyond economic development. Furthermore, these high mountain communities view mineral extraction (often not viewed as a "sustainable" practice) and historic tourism as important components of the culture of these mountains. While high alpine regions of the world may have an ecological vulnerability that accompanies concerns of overuse, the cultural aspects of high mountain recreation should also be considered in assessing sustainability and the overall quality of mountain ecosystems.

The next phase of our work measures the carrying capacity of the high alpine soils with the visitor use in order to determine the balance between sustainable use and economic development. While it will be useful to compare trade-offs between soil condition and economic goals, decisions about what constitutes sustainability will come down to the preferences of those who live in the community and those who use the mountain ecosystem services.

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11

‘Anthropogenic Intensity’ and ‘Coastality’: Two new Spatial Indicators for Exploring & Monitoring the Coastal Areas, in the framework of Environmental Management

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Hellas

1. Introduction

The history of human settlement and the international demographic statistics prove that villages and cities of any type and size seek to be concentrated in a narrow ribbon of land, near the shorelines. [Mumford, 1961; UNFPA, 2007; WRI, 2010].
Moreover, because of their affluent resources and historically confirmed attractiveness, coastal areas have been among the most exploited areas all over the world. Therefore, it is not surprising that a cruel conflict takes place between the natural coastal environment (as a long-term supplier of special and unique resources) and the constantly increasing demand for continuous (over)use of coastal resources. At a second level, even stronger conflicts take place among human activities, as they are expressed through the coastal land uses. [Stanners & Bourdeau, 1995; EC, 1999; UNEP, 2001; Benoit & Comeau, 2005; EEA, 2006; Valiela, 2006; Goudie, 2006; UNEP/PAP/RAC, 2009].
Because of the (greater than ever) international concern on sustainable development principles, the coastal issues are already enough highlighted. The related academic literature and institutional concern are enormously expanded. [WCED, 1987; Brachya et al., 1994; Benoit & Comeau, 2005; CIESIN, 2010].
Having the above facts as starting point, this chapter belongs to the integrated coastal area management research field. It aims to trigger off the development of a more comprehensive approach of coastal areas, as the already available coastal information (and related indicators) does not sufficiently satisfy the spatial notion of the coastal areas, especially at local level. The general concept is to prove that the two newly launched indicators, **‘Anthropogenic Intensity’ and ‘Coastality’, are emerging with efficiency the spatial notion of coastal areas, and thus they are able to support the planning-exploring-monitoring process of coastal space**, in the perspective of territorial cohesion and sustainable development.
After a brief review of the international scientific agenda, regarding the coastal issues (in particular from the spatial planning point of view), a critical overview is recorded, concerning the indicators already been in use through the coastal management process. But, the core of the present text is dedicated to the full description of these two new indicators. Additionally, an epigrammatic synopsis of the already completed case studies is

demonstrated. These case studies have been implemented along the Hellenic coasts, from 2006 to 2009.
The new indicators' effectiveness, their ability to propose a new coastal typology and their potential future improvement will be also discussed. The contribution of this chapter will be considered as positive if the illustrated new indicators achieve to enrich the argument about the (integrated) environmental management and the sustainable development of the coastal space.

2. Coastal space

2.1 Basic coastal ontology

'Coastal areas' consist from the land and sea areas bordering the shoreline. [ENCORA, 2010].
More precisely, according to a rather old but classic definition, a 'coastal zone' contains:

> *"The part of the land affected by its proximity to the sea, and that part of the sea affected by its proximity to the land as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology". [Stanners & Bourdeau, 1995, from US Commission on Marine Science, Engineering and Resources, 1969; USC, 1972].*

According to the recent Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean, 'coastal zone' means:

> *"The geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities". [UNEP/MAP/PAP, 2008].*

The terms: (coastal) area/zone/space have a similar but not completely equal meaning. The 'zone' usually refers to limits (landward and seaward) "parallel" to the shoreline, the 'area' is a more general concept, without restrictions regarding the limits (so, it is proposed for cases where the coastal limits match with the rather random administrative boundaries or the watershed perimeter) and finally the term 'space' is used by spatial planners in order to assist the focusing on the spatial notion. In addition, the French origin term 'littoral' refers to a rather narrow zone between the limits of high and low tides; even if the term 'littoral zone' is used for a more extended coastal area. The term 'coastal environment' is favoured when the focal point is on the natural ecosystems. Throughout a systematic approach, the term 'coastal system' can be used. Finally, the term 'coastal region' is not very common, particularly at local level.
Because of the fuzziness of the coastal area notion, there is a difficulty to reach a single scientific description of this term. Biological, chemical, geomorphologic, oceanographic, legislative and other criteria drive to various definitions, both scientific and operational; the latter are used with the intention of solving specific managerial/administrative coastal problems. Almost all of them (especially these with scientific starting point) accept a double composition of coastal areas, by identifying a land and a marine part. [Clark, 1995; Kiousopoulos, 1999].
Usually, during the planning process a three-dimension approach is chosen, as it is widely accepted that the intensity of the coastal phenomena is gradually changed, with the pick taking place very close to the shoreline. Furthermore, the international literature accepts the existence of coastal phenomena around a (large) lake or river.
In accordance with the previous analysis, it is understandable that a critical point of every coastal project is the location of the coastal areas limits, both landward and seaward. This

geographical coverage specification is very essential landward, "*in order to apply, inter alia, the ecosystem approach and economic and social criteria and to consider the specific needs of islands related to geomorphologic characteristics and to take into account the negative effects of climate change*" [UNEP/MAP/PAP, 2008].

2.2 Current situation

No important how they are defined (and beyond the unavoidable impact of natural processes) coastal areas are arenas of human-environment interactions. Their particular characteristics attract human activities in an increasing rate. As a result, coastal space needs to be controlled by means of policies such as spatial planning, integrated coastal area management, environmental assessment etc. Usually, environmental, economic and social dimensions are recognized; but lately, governance issues are present with an emphatic way. [Brachya et al., 1994; EC, 1999; UNEP, 2001; Heileman, 2006].

Coastal space is under intense pressure due to: uncontrolled urban expansion, tourism development, intensive agricultural production and diversification of fishery activities, energy production, "mobility and commerce–ports, harbours and coastal transport routes" and many other human activities. [Clark, 1995; EC, 1999; Valiela, 2006]. The expected growth, particularly in the tourism sector, increases human pressure on natural, rural and urban coastal environments. [UNEP/PAP/RAC, 2009]. However, there is no adequate information to cope with the real magnitude of human impact on coastal areas. [UNEP, 2001; Creel, 2003; EPA, 2009].

Along the already overdevelopment coasts, like those of the Mediterranean region, the process has been progressing for several decades. It leads almost inevitably to an artificial land cover over the previously natural environment. [Stanners & Bourdeau, 1995; Benoit & Comeau, 2005; Vogiatzakis et al., 2005]. On the other hand, today, the global coastal system faces a rather vague future. Indeed, it is quite certain that climate change and sea level rise will stress coastal resources and afterwards will interact with many social and environmental factors, as population growth, use of resources etc. [EEA, 2006; UNFPA, 2007; NOAA, 2009].

Simultaneously, the massive demand of coastal space increases the number of involved actors. Local population and the businessmen with economic interest in coastal space are at the first level of concern for the coastal affairs. Visitors and tourists compose a second group. Local authorities and numerous ministries of the central government follow, but often find themselves undertaking the same or similar tasks and sometimes, even working against each other due to their own inharmonious and competing objectives. Besides, many public, non public agencies and NGOs are occupied in different coastal issues.

It is remarkable that the majority of the just before mentioned stakeholders are apparently not experienced in coastal planning and management. Moreover, beyond the competing needs of the implicated stakeholders, other parameters as temporality (that drives to "seasonal land uses"), the overlapping of terrestrial and marine features, the regionally diversified natural phenomena etc. make the management of coastal areas quite complicated, a rather fuzzy process.

The policy response fluctuates widely, but during the last 30 years and especially after the Earth Summit held in Rio de Janeiro, 1992, coastal nations are encouraged to develop their own Integrated Coastal Zone Management (ICZM) infrastructures. [UN, 1992; Brachya et al., 1994; UNEP, 2001]. In accordance with the above mandate, many efforts have been done all

over the world, but not all of them can be considered as successful. Besides, no seldom, they deal only with just the marine/ocean part or the land part of a coastal area.
In our days, after a long period of experience, ICZM seems to be a temporally extended process of continuous confronting efforts against social, economic and political interests, which usually protect the existing status quo. Consequently, even if it is yet promoted as the ideal solution, in many cases, ICZM seems to be only a "*part of the rhetoric for sustainable development*". [Sorensen, 2002]. Thus, ICZM is rather an umbrella that includes all the coastal areas planning and management procedures, in general.

3. Coastal indicators

3.1 General overview

The study of coastal areas through indicators is strongly recommended by the international bodies devoted to coastal and environmental issues. It is remarkable that according to the 'Agenda 21' -and especially to the passage of the article 17 ("protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources") dedicated to data and information (article 17.8)- the promotion of indicators is very clear [UN, 1992]:

> *"Coastal States, where necessary, should improve their capacity to collect, analyse, assess and use information for sustainable use of resources, including environmental impacts of activities affecting the coastal and marine areas. Information for management purposes should receive priority support in view of the intensity and magnitude of the changes occurring in the coastal and marine areas. To this end, it is necessary to, inter alia:*
> *(a) Develop and maintain databases for assessment and management of coastal areas and all seas and their resources;*
> *(b) Develop socio-economic and environmental indicators;*
> *(c) Conduct regular environmental assessment of the state of the environment of coastal and marine areas;*
> *(d) Prepare and maintain profiles of coastal area resources, activities, uses, habitats and protected areas based on the criteria of sustainable development;*
> *(e) Exchange information and data."*

In parallel, the European Union directives on the assessment of almost every human construction of large scale endorse goals which are equivalent to the previously mentioned information/indicators demand of ICZM. Indeed, the under discussion TIA (Territorial Impact Assessment), the already existed Environmental Impact Assessment (EIA), but even more the Strategic Environmental Assessment (SEA) require on-going information on the earth territory status, coastal areas included. All of them (ICZM and TIA/EIA/SEA) fuel a continuous need of geographic information, especially after the recent more persistent promotion of the spatial cohesion notion, through the 3rd and the 4th reports of European Commission on Economic and Social Cohesion. [EC, 2004; EC, 2007].
As the supply of efficient and effective information is one of the greater needs -if not the greatest one- for successful management of coastal space, the research on indicators -as an analysis tool- is widespread along the academic community and the institutional bodies. [UN, 2001; OECD, 2001; Bossel, 1999; UNEP, 2000; Nebert, 2004; EEA, 2005]. Existing indicators useful for ICZM and in general for the coastal space can be distinguished into several categories, but mainly into the two already reported in the above quotation of the 'Agenda 21': the socio-economic and the environmental category.

Beyond the criterion of specialization, the indicators can be categorized according to the frameworks, in which they belong. The more well-known are: the Pressure-State-Response (PSR) framework (launched and supported by UN and OECD) and the Driving forces – Pressure – State – Impact – Response (DPSIR) framework (launched and supported mainly by EU and the affiliate agencies). [OECD, 2001; Smeets & Weterings, 1999; Heileman, 2006].
Very close to the indicators issues, the ambitious initiative INSPIRE of the European Union aims to solve problems such as the fragmentation of datasets and sources, the lack of harmonization between datasets at different geographical scales, the gaps in information availability etc. [INSPIRE, 2010]. Similar objectives are evident in the analogous international initiative of the GSDI Association. [GSDI, 2010].
Until nowadays, a huge number of indicators (simple or with the form of a complex algorithm) or sets of indicators have been launched, mainly for environmental use. [Smeets & Weterings, 1999; UNEP, 2000; UN, 2001; Barbière, 2003; EEA, 2005; Heileman, 2006]. Some of those indicators are registered in Table 1. The first group refers to a general approach concerning the sustainable development. The second and the third are specialized to ICZM (in Mediterranean and in oceans, accordingly), while the fourth one has been used in a smaller ICZM project (in the Belgian coast).

Percent of Population Living below Poverty Line, Gini Index of Income Inequality, Unemployment Rate, Ratio of Average Female Wage to Male Wage, Nutritional Status of Children, Mortality Rate Under 5 Years Old, Life Expectancy at Birth, Percent of Population with Adequate Sewage Disposal Facilities, Population with Access to Safe Drinking Water, Percent of Population with Access to Primary Health Care Facilities, Immunization Against Infectious Childhood Diseases, Contraceptive Prevalence Rate, Secondary or Primary School Completion Ratio, Adult Literacy Rate, Floor Area per Person, Number of Recorded Crimes per 100,000 Population, Population Growth Rate, Population of Urban Formal and Informal Settlements, Emissions of Greenhouse Gases, Consumption of Ozone Depleting Substances, Ambient Concentration of Air Pollutants in Urban Areas, Arable and Permanent Crop Land Area, Use of Fertilizers, Use of Agricultural Pesticides, Forest Area as a Percent of Land Area, Wood Harvesting Intensity, Land Affected by Desertification, Area of Urban Formal and Informal Settlements, **Coastal Zone Algae Concentration in Coastal Waters**, **Percent of Total Population Living in Coastal Areas**, Annual Catch by Major Species, Annual Withdrawal of Ground and Surface Water as a Percent of Total Available Water, BOD in Water Bodies, Concentration of Faecal Coliform in Freshwater, Area of Selected Key Ecosystems, Protected Area as a % of Total Area, Abundance of Selected Key Species, Economic Performance GDP per Capita, Investment Share in GDP, Balance of Trade in Goods and Services, Debt to GNP Ratio, Total ODA Given or Received as a Percent of GNP, Intensity of Material Use, Annual Energy Consumption per Capita, Share of Consumption of Renewable Energy Resources, Intensity of Energy Use, Generation of Industrial and Municipal Solid Waste, Generation of Hazardous Waste, Generation of Radioactive Waste, Distance Travelled per Capita by Mode of Transport, Strategic Implementation of SD, National Sustainable Development Strategy, Implementation of Ratified Global Agreements, Number of Internet Subscribers per 1000 Inhabitants, Main Telephone Lines per 1000 Inhabitants, Expenditure on Research and Development as a Percent of GDP, Economic and Human Loss Due to Natural Disasters. [UN, 2001].
Population growth, Total fertility rate, Women per hundred men in the labour force, Human poverty index, Employment rate, School enrolment gross ratio, Difference between male and female school enrolment ratios, Production of cultural goods, Share of private and public finances allocated to the professional training, Public expenditure for the conservation and value enhancement of nature, cultural and historical patrimony, Life expectancy at birth, Public expenditure for the conservation and value

enhancement of natural, cultural and historical patrimony, Public expenditure for the conservation and value enhancement of natural, cultural and historical patrimony, Life expectancy at birth, Infant mortality rate, Access to safe drinking water, Annual energy consumption per inhabitant, Number of passenger cars per 100 inhabitants, Main telephone lines per 100 inhabitants, Distribution of food consumption per income decile, Urban population growth rate, Loss of agricultural land due to the urbanisation, Urbanisation rate, Floor area per person, Population change in mountain areas, Existence of program(s) concerning the less favoured rural zones, Exploitation index of forest resources, Forest area, Forest protection rate, **Artificialized coastline / total coastline, Number of tourists per km of coastline, Number of moorings in yachting harbours, Population growth in Mediterranean coastal regions, Population density in coastal regions, Coastline erosion, Protected coastal area, Oil tanker traffic, Global quality of coastal waters, Density of the solid waste disposed in the sea, Coastal waters quality in some main "hot spots"**, Quality of biophysical milieu, Protection of specific ecosystems, Existence of monitoring programs concerning pollutant inputs, **Wastewater treatment rate before sea release for coastal agglomerations over 100 000 inhabitants, Harbour equipment ratio in unballasting facilities**, Distribution of GDP (Agriculture, Industry, Services), Foreign Direct Investment, External debt / GDP, Saving / investment, Public deficit / GDP, Current payments / GDP, Employment distribution (Agriculture, Industry, Services), Use of agricultural pesticides, Use of fertilisers per hectare of agricultural land, Share of irrigated agricultural land, Agriculture water demand per irrigated area, "Arable land" per capita, Rate of food dependence, Annual average of wheat yield, Water use efficiency for irrigation, Value of halieutic catches at constant prices, Number and average power of fishing boats, Fishing production per broad species groups, Production of aquaculture, Public expenditures on fish stocks monitoring, Industrial Releases into water, Intensity of material use, Number of mines and carries rehabilitated after exploitation, Turnover distribution of commerce according to the number of employees, Share of merchant services to the enterprises, Existence of legislations on the hypermarket setting up restriction, Energy intensity, Energy balance, Share of consumption of renewable energy resources, Average annual distance covered per passenger car, Structure of transport by mode, Density of the road network, Share of collective transport, Number of nights per 100 inhabitants, Number of secondary homes over total number of residences, Number of bed-places per 100 inhabitants, Public expenditure on tourism development, Number of international tourists per 100 inhabitants, Share of tourism receipts in the exportations, Currency balance due to tourism activities, Public expenditure on tourism sites conservation, Exploitation index of renewable resources, Non-sustainable water production index, Share of distributed water not conform to quality standards, Water global quality index, Share of collected and treated wastewater by the public sewerage system, Existence of economic tools to recover the water cost in various sector, Drinking water use efficiency, Share of Industrial wastewater treated on site, Ratio of land exploitation, Land use change, "Arable land" change, **Wetland area, Number of turtles cached per year, Share of fishing fleet using barge,** Threatened species, Total expenditure on protected areas management, Generation of municipal solid waste, Generation of hazardous wastes, Imports and exports of hazardous wastes, Generation of industrial solid waste, Area of land contaminated by hazardous wastes, Distribution of municipal wastes, Minimisation of waste production, Cost recovery index of municipal wastes, Destination of household wastes, Collection rate of household wastes, Emissions of greenhouse gasses, Emissions of sulphur oxides, Emissions of nitrogen oxides, Consumption of ozone depleting substances, Frequency of excess over air standard (ozone), Expenditure on air pollution abatement, Share of clean fuels consumption in total motor fuels consumption, Share of agglomerations over 100 000 inhabitants equipped with a air pollution monitoring network, Number of sites with high risk, Economic impact of natural disasters, Burnt area per year, Existence of intervention plans, Number of direct employments linked to the environment, Number of associations involved in environment and/or sustainable development, Number of enterprises engaged in "environment management" processes, Public expenditure on environmental protection as a percent of GDP, Existence of environment national plans and/or sustainable development strategies, Number of Agendas 21 adopted by local authorities, Openness rate of GDP, Net migration rate, Public development assistance coming from abroad.
[UNEP, 2000].

Value of living resources, Value of non-living resources, Non-consumptive uses, Economic value-added, Value of exports, Management & administration costs, Investment by government, Private sector investment, Foreign direct investment, Number employed, Employment payroll value, Same sub-categories as total economic value, **Land-based activities dependent on the marine environment**, **Activities in the ICOM area out to the boundary of the EEZ or the continental shelf**, Non-living resource exploitation, Non-consumptive use, Land use/land cover patterns & composition, Population density, Extent of hard-surface areas, **High-impact fishing gear/practices**, Dumped & dredged material, Population served by wastewater treatment, Volume, no. & type of point-source discharges, Non-point-source nutrient loading, Discharged sediments and nutrients, Litter & debris. [Heileman, 2006].
Degree of unemployment, Employment in the tourist sector, Number of good renovations and restorations, Change in employment in the sectors of fish and agriculture, Fish stocks out of the biological limits, Ratio of business started/bankrupt, Value added per employee, **Efforts concerning integrated coastal zone management**, Pressure on incomes, The population structure, Housing quality, **Bathing water quality**, Domestic waste, Number of pollutions (oil) observed/hour flying time, **Surface of typical seaside habitat**, Surface of the protected green area, Number of accommodation with easy access, Ratio resident/non-resident tourism, Traffic pressure on the road, Economic value of the shipping industry versus emission of toxic dust. [Maelfait et al., 2006].

Table 1. Indicative catalogue of several of the already existent indicators, they could be used in coastal management projects.

3.2 Critical approach

Normally, environmental indicators cover the general needs of coastal projects, but not in an adequate way. The majority of the indicators listed in Table 1 are not designed exclusively for coastal areas. But, what is the more essential is that these indicators do not pay attention on the spatial notion. This means that **the geomorphologic geographic information, that characterizes and gives a unique identity in every coastal area, is not regarded as valuable to be incorporated in the majority of the already proposed indicator**. Therefore, vital spatial information for coastal geomorphology is either missing or ignored, even if the "geomorphologic area" is the core of the coastal zone definition, according to the Protocol on Integrated Coastal Zone Management [UNEP/MAP/PAP, 2008].

The indicators of Table 1 can be classified into international, national, regional and (rarely) local level of approach, regarding the geographical scale of their potential use. The ones related to coastal areas are rather suitable for international, national or regional approach [UNEP, 2000]; at any rate, they are no committed to geomorphologic information. In the literature, there are available indicators respecting spatial concept at local level [Chalkias, 2002], but they limit their interest mainly to the islands.

Finally, because there are not indicators supporting the local approach, a small coastal area can neither be easily explored and monitored nor be compared with another coastal area (of equal size). Simultaneously, there is no indicator to cope with either the human impact on a coastal area, in general, or more specifically, with the bulk of man-made coastal environment (constructions of any kind and size).

Because of the previously proved lack of coastal information/indicators indented to depict:

- the spatial notion,
- the local identity and

- the total human impact,

a continuous effort to improve and to expand the already used system of indicators is needed. In this context, indicators suitable for: i) exploring (with the meaning of analysis) and monitoring the coastal areas, ii) enriching spatial planning, in general, iii) supporting all the involved stakeholders and iv) getting on a successful governance process on a coastal area, should incorporate geomorphologic factors as the following:

1. **Position**, with potential parameters like: location, vicinity, orientation etc.,
2. **Geometry**, with potential parameters like: shape, distance etc.,
3. **Topography**, with potential parameters like: elevation, slope, drainage etc.,
4. **Geology**, with potential parameters like: shore type, beach rocks, dunes, deltas, tectonics etc.

Beyond the previous preconditions and in order to convert reliably (coastal) data into (coastal) information, during the planning/exploring/monitoring process, an indicator (of Pressure or State type, according to the DPSIR framework) should fulfill the following general requirements:

a. be clearly defined,
b. be representative, relevant and reliable,
c. be easy and inexpensive in measuring and
d. be grounded on scientific theory and be applicable into future policies.

Moreover, a new coastal indicator is preferable to: α) be flexible enough, in order to supply the possibility of a future improvement and β) have the ability to support the building of a new coastal typology.

During the last decade, a number of new indicators have been introduced, after team work at the Spatial Analysis Laboratory of Technological Educational Institute of Athens. 'Vicinity' and 'Ideal Shoreline' are some of them, belonging to the first period. More recently, the indicators 'Anthropogenic Intensity' and 'Coastality' have been proposed. [Kioussopoulos, 1997; Kiousopoulos, 1999; Kiousopoulos & Lagkas, 2005; Kiousopoulos, 2008a; Kiousopoulos, 2008b; Kiousopoulos et al., 2008; Kouki et al., 2008].

4. Anthropogenic Intensity

4.1 The concept

Coastal areas attract a big variety of human activities. The last ones, as they are expressed by the (coastal) land uses, impact the natural coastal environment in an unpredictable (and more or less aggravating) degree. Anthropogenic Intensity[1], (AI), aims to answer the question "How intense are the human activities along a coastal area?" and consequently to become a feasible tool to assess all the human activities along a specific coast, at a time. In this context, Anthropogenic Intensity provides information about the amount of human intervention on a studied coastal area, by measuring the man-made "volume" of the building and all the anthropogenic constructions.

Until the beginning of 2010, this indicator has been studied only in relation to the terrestrial part of the coastal areas.

The geographic scale (that affects the size of the studied coastal area) has been chosen to be closer to the local level of (spatial planning) approach. The landward edge of a coastal area

[1]In all the past books, paper and other publications of the author, this indicator was named Anthropogenetic Intensity', but from this text onwards it is renamed 'Anthropogenic Intensity'.

is decided to be at a distance no longer of 10 km from the shoreline, a well-accepted limit in the ICZM projects and the European Union related paradigms of good practice.
The methodology contains, first of all, the recognition of polygons or pixels with single (or one dominant) land use (or land cover) and the same height of connected man-made constructions of any type. Additionally, a full detailed scheme with all the observed land uses should be available, plus a (a priori) quantitative estimation of the impact of each of them on the environment. It is recommended that the previous scheme to be supplemented with the (estimated/supposed) heights of the man-made constructions for each observed land use/cover. These heights values can be used alternatively to the observed real ones.
Common and very suitable sources of data are satellite images, but other sources can be used, as well. Furthermore, this indicator is depended, mainly, on digital data and sources.

4.2 Formula & comments

At a first level of approach, every polygon or pixel with (observed) single land use (or land cover) is represented by its surface, (s). Secondly, the man-made constructions height, (h), on each area-unit (polygon or pixel) is a critical size that is also implicated. Next, weights, (w), for each land use are used to express the real human impact on the coastal space as the result of each observed land use. With these parameters, Anthropogenic Intensity (AI) can be calculated according to the following formula (1), for a coastal area with total surface equal to S.

$$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i}{S} \tag{1}$$

At a more thorough approach, in order to further correlate the man-made impact with the distance from the shoreline (D), this distance (as it is expressed by the integer part of the related value in km) is involved into the formula. The influence of D is minimized gradually, from the shoreline to the landward coastal area limit (here: 10 km from the shoreline). This approach leads to the calculation of the Anthropogenic Intensity, (AI), with the alternative (and more specified) formula (2):

$$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i \cdot \left(1 - 0{,}1 \cdot \operatorname{int} D_i\right)}{S} \tag{2}$$

where: s_i: area of each polygon/pixel with single land use/cover and the same height of man-made constructions,
h_i: the height of man-made constructions, in each polygon/pixel, in meters,
w_i: weights for each land use/cover,
int D: the integer part of the distance (D, in km) from the shoreline, for each polygon/pixel,
S: the total area of all the polygons/pixels (the total coastal area under examination), in the same unit as s_i.

Anthropogenic Intensity, (AI), is expressed in meters and this value depicts the "mean height" of buildings and all other constructions on a coastal area, at a time.
The value AI = 0 m (zero meters) indicates a pure natural coastal environment, without any man-made invasion.

The version (1) is built without the Distance component. It means that there is no importance where exactly (how far away from the shoreline, but inside the studied coastal area) each land use/cover is located. According to this version, all the AI values are positive.
The version (2) is built with the Distance component. It means that there is great significance where exactly (how far away from the shoreline, but inside the studied coastal area) each land use/cover is located. According to this second (full) version of the Anthropogenic Intensity formula, all the AI values are positive inside a coastal zone of 10 km.
The version (2) can be operationally useful, even in the case of a coastal area with 'Width'[2] greater than 10 km, in two ways. Firstly, by an appropriate change of the formula (2), where another suitable constant value is put instead of the constant '1' (that corresponds to 10 Km). Secondly, by using the same formula without change. In this case, the addition of area-units (polygons/pixels) with man-made constructions (in distances greater than 10 km from the shoreline) generates AI' values gradually smaller. That is reasonable as the added man-made constructions are not so close to the sea, so, the (indirect) impact on the studied 10 km coastal area becomes relatively smaller. Only in this last case, the AI' values could be possibly negative.
For coastal zones with 'Width' less than 1 km, the two versions of the AI formula are practically the same.
Anthropogenic Intensity, (AI), reveals the degree of economic activities, the intensity of land uses and the total stress caused by mankind along a delimited coastal area. So, it could be an appropriate tool for exploring and monitoring a coastal area, in the context of environmental management.
But the most important and valuable advantage can be arisen from the differences of values at the same coast at two different times or at different coasts the same time. The size of these differences could be used as an alert to activate already established coastal policy's mechanisms.

4.3 Anthropogenic Intensity's case studies

In order to test the new indicator, numerous case studies have been implemented along the Hellenic coasts, from 2006 to 2007. The following three places of the continental part of Hellas have been selected (see Fig. 1):

1. NAFPAKTOS,
2. KYPARISSIA,
3. PREVEZA.

These places have been decided in order neither to be in the islands (where the coastal phenomena are very strongly dominated by only one land use, tourism) nor to be very populated (because of the special prevailing conditions in the urban areas, which maybe deteriorate the coastal characteristics).
The maximum studied coastal area surface in each region is: 185,4 sq. km (I, NAFPAKTOS), 10,2 sq. km (II, KYPARISSIA) and 137,2 sq. km (III, PREVEZA). Smaller territorial parts have

[2]The indicator 'Width' or 'Depth', (B), of the land part of a coastal area is used to depict how far away from the shoreline the terrestrial part of the examined coastal area exceeds, if the coastal area is supposed to be a zone with single width. A small value of B means that the coastal area has a relatively extensive waterfront and thus there is a high interaction between the marine and the (narrow) land part. A high value of B shows that the examined coastal area exceeds far away from the shoreline, landward, so limited coastal phenomena can be recognised there. [Kiousopoulos, 2008b].

been studied, too, by choosing different 'Width' in the same coastal area. In this way, 19 values of the new indicator have been calculated. (see Table 4).

INDICATOR NAME / SYMBOL	**Anthropogenic Intensity / AI**
GENERAL OBJECTIVE	The quantitative calculation of human impact on a coastal area, in a given time, via the measurement of the height of all the man-made constructions, in relationship to the distance from the shoreline.
FORMULA	$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i \cdot (1 - 0{,}1 \cdot \text{int} D_i)}{S}$
VALUE RANGE	Relatively small positive real numbers expressed in meters, included zero value. (Negative values are possible only if something like this is designed).
MEASUREMENT FREQUENCY	Every 5 or 10 years, according to source availability.
METHODOLOGY – SOURCES	Polygon/pixel delineation for each land use upon digital maps, orthophotographs etc.
ADDITIONAL NEEDS	Formation of land uses/covers classification scheme. Decision on weight factors per land use/cover. (Estimation of constructions' heights.)
AVAILABILITY OF SOURCES	Relatively high.
APPLICATION SPATIAL LEVEL	Local and only along the terrestrial part, until today.

Table 2. Anthropogenic Intensity in brief.

Fig. 1. Map of Hellas (Greece) with the locations of the three AI case studies (Nafpaktos, Kyparissia and Preveza) and the location of the one Coastality case study (Milies).

The maximum values of 'Ideal Shoreline'[3] for the three studied main coastal area are: 21,0 km, 13,8 km and 19,0 km, accordingly.
Throughout the 19 case studies, three schemes of land use/cover classification have been used. One of them is shown in Table 3 (it is this of type 'A' in Table 4).
The coastal areas of Nafpaktos and Preveza have been studied in two different points of time, each of them, as it is explained by the code in the left column of Table 4.

LAND USES	HEIGHT, H	WEIGHT, W	h * w
ARABLE LAND / PASTURES	1,0	0,5	0,5
FRUIT TREES	3,0	0,5	1,5
FORESTS	10,0	0,0	0,0
INDUSTRIAL AREAS	15,0	5,0	75,0
SMALL INDUSTRIES / WAREHOUSES	8,0	4,0	32,0
MINES / QUARRIES	5,0	5,0	25,0
HIGHWAYS	5,0	5,0	25,0
NATIONAL ROADS	4,0	4,0	16,0
SECONDARY / RURAL ROADS	3,0	3,0	9,0
FOREST ROADS	3,0	2,0	6,0
RAILWAY NETWORK	5,0	2,0	10,0
PORTS	10,0	4,0	40,0
AIRPORTS	10,0	5,0	50,0
ENERGY NETWORKS	15,0	2,0	30,0
MANAGEMENT OF WASTES	3,0	4,0	12,0
BIG CITIES [> 100.000 residents]	25,0	3,0	75,0
CITIES [> 10.000 residents]	15,0	2,5	37,5
TOWNS [> 2.000 residents]	8,0	2,0	16,0
VILLAGES [< 2.000 residents]	5,0	1,5	7,5
UNDER POPULATED (SPRAWLING) AREAS	5,0	1,0	5,0
ISOLATED BUILDINGS	10,0	2,0	20,0
TOURISM DEVELOPMENTS	10,0	2,0	20,0

Table 3. Indicative scheme (type A, see Table 4) of observed land uses, the pre-supposed heights of the related constructions and the chosen weights. [Kiousopoulos, 2008a].

In Fig. 2, the results for Nafpaktos study area in two times (1985 and 2007) are illustrated. For the first case (1985), 5 aerial photos (30cm * 30cm, scale 1:6.000) from the Hellenic Mapping & Cadastral Organization were used. For the year 2007, 5 satellite images from Google Earth were used. In both cases, Anthropogenic Intensity is calculated by using the version (1) of the AI formula.
In Fig. 3, four results in the coastal area of Kyparissia are illustrated, produced by choosing different 'Width' of the examined coastal zone (0,5 km, 1 km, 2 km and 5 km).

[3]The indicator 'Ideal Shoreline' refers to a delimited coastal area and it is defined as the straight distance between the two end points of the related shoreline, in the waterfront. In cases of an island, 'Ideal Shoreline' is equal to the length of a circle's perimeter that has area equal to the area of the island. 'Ideal Shoreline' is a numeric quantity expressed in length units. [Kiousopoulos 2008b].

Fig. 2. The study area and the results of AI case studies in a zone (with Width equal to 2 km), in Nafpaktos, during two different times, 1985 and 2007. (See Table 4, codes: nI/85&nI/07).

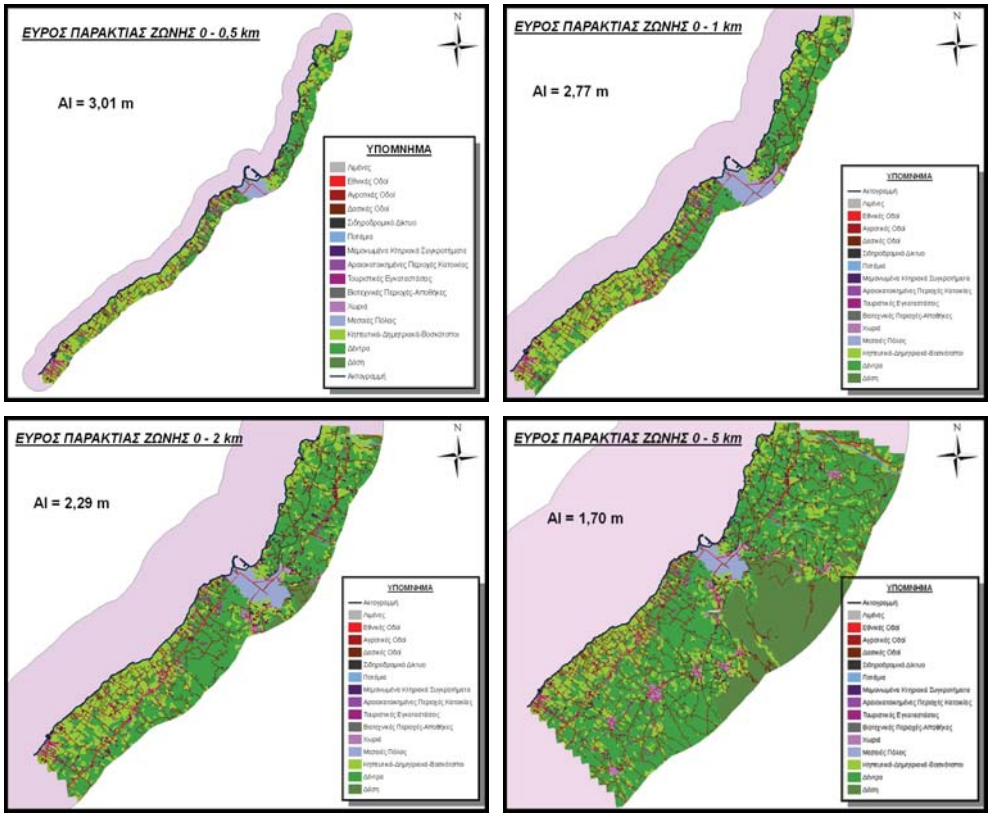

Fig. 3. The area and the results in four cases (with different 'Width') in KYPARISSIA, at the same time, 2007. (See Table 4, codes: kII/07, kVII/07, kVIII/07 & kIX/07).

The results and the related specifications of all the AI' case studies are demonstrated in Table 4. The case studies have been realised with different specifications, in order the formula been tested under dissimilar conditions. So, the results cannot be fully compared, but it is obvious that the new indicator works! E.g. in a very narrow coastal zone near the

shoreline (where the human stress is big), the AI value is big. In a coastal zone with relatively big 'Width' (where the human stress becomes relatively smaller), the AI value is small.

COASTAL AREA, CODE	COASTAL ZONE (LANDWARD) LIMIT (km)	SCHEME OF LAND USES/COVERS	VERSION OF AI' FORMULA	TOTAL SURFACE (km²)	'IDEAL SHORELINE' LENGTH (km)	AI VALUE (m)
ΝΑΥΠΑΚΤΟΣ, nI/85	0 - 2	A	*(1)*	4,2	5,2	4,10
ΝΑΥΠΑΚΤΟΣ, nI/07	0 - 2	A	*(1)*	4,2	5,2	8,70
ΝΑΥΠΑΚΤΟΣ, nII/07	0 – (12)	B	*(1)*	185,4	21,0	1,41
ΚΥΠΑΡΙΣΣΙΑ, kI/07	0 - 10	B	*(1)*	100,2	13,8	1,66
ΚΥΠΑΡΙΣΣΙΑ, kII/07	0 - 0,5	B	*(1)*	11,4	13,8	3,01
ΚΥΠΑΡΙΣΣΙΑ, kIII/07	0,5 - 1	B	*(1)*	11,2	(13,8)	2,53
ΚΥΠΑΡΙΣΣΙΑ, kIV/07	1 - 2	B	*(1)*	19,1	(13,8)	1,73
ΚΥΠΑΡΙΣΣΙΑ, kV/07	2 - 5	B	*(1)*	50,1	(13,8)	1,21
ΚΥΠΑΡΙΣΣΙΑ, kVI/07	5 – (10)	B	*(1)*	8,5	(13,8)	1,27
ΚΥΠΑΡΙΣΣΙΑ, kVII/07	0 - 1	B	*(1)*	22,5	13,8	2,77
ΚΥΠΑΡΙΣΣΙΑ, kVIII/07	0 - 2	B	*(1)*	41.7	13,8	2,29
ΚΥΠΑΡΙΣΣΙΑ, kIX/07	0 - 5	B	*(1)*	91,8	13,8	1,70
ΚΥΠΑΡΙΣΣΙΑ, kX/07	0 – (10)	B	*(2)*	100,2	13,8	1,16
ΠΡΕΒΕΖΑ, pI/60	0 - 8	Γ	*(1)*	137,2	19,0	1,16
ΠΡΕΒΕΖΑ, pII/60	0 - 2	Γ	*(1)*	40,3	9,1	1,20
ΠΡΕΒΕΖΑ, pI/07	0 - 2	Γ	*(1)*	18,2	9,2	1,93
ΠΡΕΒΕΖΑ, pII/07	0 - 1	Γ	*(1)*	14,2	9,2	2,20
ΠΡΕΒΕΖΑ, pIII/07	1 - 2	Γ	*(1)*	4,0	(9,2)	0,97
ΠΡΕΒΕΖΑ, pIV/07	0 - 2	Γ	*(2)*	18,2	9,2	1,91

Table 4. The specifications and the results of the Anthropogenic Intensity case studies. [Kiousopoulos, 2008a].

5. Coastality

5.1 The concept

Coastality is not a common term. It is very rarely used [Plane, 2005]. The majority of dictionaries and glossaries do not contain the entry 'coastality'. But, according to the more probable etymological explanation, it seems to express the proximity to the sea and maybe the quality of living next to the seashore.

In our research, the term Coastality (C) has been chosen, since 2005, as the name of a new indicator aiming to answer the question "How coastal is a coastal area?". In this way, Coastality intends to identify and to assess the coastal characteristics (of the terrestrial part of a coastal area, at local level) that originate from the "proximity to the sea".

So, first of all, Coastality needs to represent all the important sub-indicators that are able to describe correctly and completely the coastal characteristics, at local level. Beyond this rather qualitative goal, one other rather quantitative must follow, the finest formulation of the related mathematical formula.
Concerning the first very ambitious target, Coastality can reach it by a bidirectional approach that distinguishes the natural from the man-made characteristics of a coastal area. These two directions configure the two components of Coastality, (C), the Natural Coastality, (nC), and the Artificial Coastality, (aC).
The natural-abiotic features, that attract people near the seashore, belong to the Natural Coastality that aims to incorporate the so named supply of a coastal area.
On the other hand, the aim of Artificial Coastality is to incorporate all the expressions of human impact along the same coastal area, i.e. the demand for coastal space, but in a different way than AI indicator does it.
Each of these components can be manipulated in order to give values from '0' (zero) or 0% to '1' (one) or 100%. As a result, Coastality can be the sum of the two components' values and the C value will fluctuate (theoretically) from '0' (zero) to '2' (two).
An alternative idea is to keep the two values separately and in this way, Coastality will be expressed by two numbers, or percentages, the first referring to the Natural Coastality and the second referring to the Artificial Coastality e.g. '0,8 – 0,4' or '80% - 40%'.

5.2 Potential parameters and provisional formula

Until the beginning of 2010, the following approach of Natural Coastality and Artificial Coastality is the background of the ongoing related research (see Fig. 4):
1. **Natural Coastality**. It aims to determine the attractiveness of the natural coastal environment by measuring the following two sub-indicators:

- **Coastal Feeling**. It is generally accepted that the coastal feeling depends mainly on the distance from the shoreline. The altitude, the orientation, the geological forms and of course the landscape are some other significant parameters. Beyond this, other factors as psychology, legislation restrictions, safety etc. can change the Coastal Feeling from place to place and from time to time.
  The meaning of feeling is not very familiar to a regional planner, but according to the more common approaches, 'feeling' is: a) a particular sensitivity, b) the capacity of the soul for an emotional state, c) a particular emotional reaction (an 'atmosphere'), d) the general atmosphere of a place or of a situation, e) the general emotional response produced by a work of art, piece of music, a view at a landscape.
  According to another, more technical definition, feeling is "*the sense by which the mind, through certain nerves of the body, perceives external objects or certain states of the body itself; that one of the five senses which resides in the general nerves of sensation distributed over the body, especially in its surface; the sense of touch; nervous sensibility to external objects*". In this approach we can distinguish some fundamental characteristics as the following: 1) there is an initial cause, the 'external objects or certain states', 2) there is a special situation because of the cause and 3) there is an impact on '*one of the five senses*'.
  On the other hand, the experience of being near the sea incorporates the following fundamental factors:
  a. Cause. The sea, the eternally moving water, the sea-land interaction etc.
  b. Special situation, as the space-infinite views of sea and sky, the calming nature but the storms and high tides, too, watching the ships etc.

c. Impact on one of the five senses. It is obvious that somebody can see, hear, smell, taste and touch the sea depending on parameters such as: a) the distance from the shoreline, b) the inclination of the territorial part of the coastal area, c) the amount of visible sea surface, d) the distance of the visible sea surface; it is close or far away from the land, e) the general annoyance that caused from the non natural, the man-made environment, the number of people being around, near the seashore etc. [Kiousopoulos 2009].

- **Sea Visibility**. It refers to the possibility to see the sea from a place (area-unit) of the terrestrial part of a coastal area. Additionally, this indicator can depend on the possibility to see the shoreline, too. The main methodological issue is to calculate how much (%) of the sea surface or the shoreline length is visible from each area-unit of the terrestrial part. So, it can be expressed as a percentage or, alternatively, with an angle. A small percentage or angle means a small value to the Sea Visibility sub-indicator.

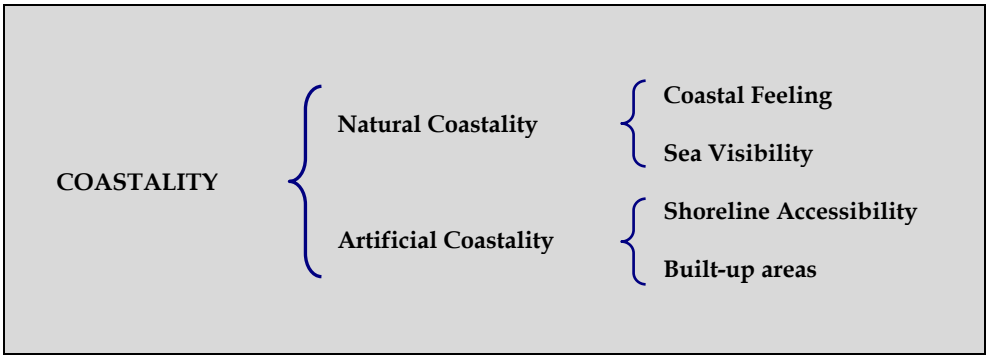

Fig. 4. The structural framework of Coastality.

2. **Artificial Coastality**. The objective is to express the size of the mankind impact on a coastal area, but in a different way from that used in the case of Anthropogenic Intensity indicator. Shoreline Accessibility via all means of transportation and the percentage of Built-up Areas within the terrestrial part of the coastal areas are the two sub-indicators, which will be used to give the Artificial Coastality value.

- **Shoreline accessibility**. It deals with the ability of a coastal area to accept massive flows of people, both from sea and land. It takes into account all means of transportation and all kind of "roads", pathways included. Probably, weights will be given concerning the carrying capacity and the scheduled intensity of itineraries of each means of transportation.
- **Built-up Areas**. It refers to the expansion of build-up areas as it is expressed by the percentage of the terrestrial part of the coastal area that is built-up and also it takes into consideration all kinds of human constructions. Opposite to the Anthropogenic Intensity indicator, this sub-indicator is not connected to the height of constructions, but only to their sprawl, to their spatial expansion.

According to the previous analysis, the formula of Coastality of a coastal area can be configured as following:

$$C = nC + aC = (\alpha \cdot c_f + \beta \cdot V) + (\gamma \cdot s_a + \delta \cdot b_a) \quad (3)$$

where: C, nC, aC: Coastality, natural Coastality, artificial Coastality,
c_f, V: Coastal Feeling, Sea Visibility,
s_a, h_a: Shoreline Accessibility, Build-up Areas,
α, β, γ, δ: coefficients.

Actually, Coastality value of a coastal area is the mean value of the related values of each point (area-unit) of the examined coastal area. Nevertheless, the formula (3) is not totally clarified, as the sub-indicators must be defined precisely and the coefficients must be thoroughly chosen.

INDICATOR NAME / SYMBOL	**Coastality / C**
GENERAL OBJECTIVE	Research on the properties which form the coastal identity. This initial aim is transformed to the aim of separate formulation of Natural Coastality (as an expression of the existing natural abiotic resources) and of Artificial Coastality (as an expression of the human impact on the coastal space).
FORMULA	$C = nC + aC = (\alpha \cdot c_f + \beta \cdot V) + (\gamma \cdot s_a + \delta \cdot b_a)$
VALUE RANGE	0,0 – 1,0 or 0% - 100% for each component.
MEASUREMENT FREQUENCY	Every 5 or 10 years, according to source availability.
METHODOLOGY – SOURCES	Specialized research studies to calculate Natural Coastality. Use of current statistics for the calculation of Artificial Coastality.
ADDITIONAL NEEDS	Full clarification of Natural Coastality and Artificial Coastality. Full definition of the implicated coefficients. Full description of the mathematical formula. Case studies with the Coastality components.
AVAILABILITY OF SOURCES	Not plenty.
APPLICATION SPATIAL LEVEL	Local at the present phase.

Table 5. Coastality in brief.

Coastality is a complex indicator which intends to evaluate coastal areas according to two components, referring both the natural and to the man-made coastal environment.
Still yet (beginning of 2010) the research interest is focused on the Natural Coastality, as it is believed that it is more difficult to be determined and calculated. So, a theoretic approach about 'Coastal Feeling' has been designed [Kiousopoulos, 2009] and a case study related to the Sea Visibility has been developed. [Kiousopoulos & Stathakis, 2009].

5.3 Sea visibility's case study

Visibility can be determined in many ways. In the framework of this case study, the notion of Sea Visibility (V), from the land part to the marine part of a coastal area, incorporates the following two factors, i) visibility to the shoreline (Vc) and ii) visibility to the sea (Vs). The values of both the factors represent the percentage of the shoreline or the sea (belonging to

the examined coastal area), accordingly, that are visible from each terrestrial location (area-unit).
The maximum value is '1' (one) or 100%, for each of the factors. Thus, the maximum value of Sea Visibility indicator is '2' (two). This value will be further transformed (during the Coastality calculation), in order the Natural Coastality value to have maximum value equal to '1' (one).
Also, for the present case study, the (initial) form of the Sea Visibility sub-indicator, for each area-unit is:

$$V = [V_C + V_S] \tag{4}$$

Two parameters have been added in the above formula, to incorporate the more probable reasons that eliminate the visual emotion/pleasure to the sea and the shoreline. The first one is the Distance, (D), from the shoreline to each examined area-unit of the coastal area terrestrial part. The second is the combination of distance and altitude, namely the Inclination, (z), of each examined area-unit. Both of them are incorporated into the formula according to the following rules:

- It is accepted that D is inversely proportional to the Sea Visibility and the produced emotion/pleasure. Indeed, the largest the Distance is, the smaller the Sea Visibility value is. So, the following admissions have been adopted: a) on the shoreline, the indicator V has the biggest value, this of formula (4), and b) in a distance equal to the double of the 'Width' (B) size, the value of the indicator V becomes equal to '0' (zero). Alternatively to this limit, an ad hoc limit (e.g. 10 km) can be used as the edge beyond which Sea Visibility values become equal to '0' (zero).
- The value of (z) is the slope of the ground at each examined area-unit of the coastal area. One more admission is that the contribution of this parameter should be neutral for slopes equal to 10% (z=0.1 or an approximate 5.7° angle). Additionally, as the value of (z) deviates (above or below) from the 10% set, this acts negatively to the Sea Visibility value. In other words, slopes other than the 10% are associated with a negative impact on Sea Visibility possibility, the produced emotion/pleasure and the general coastal attractiveness. The value of V becomes equal to '0' (zero) due to excessive slope (47.7° angle).

Consequently, during this case study, the formula for calculating Sea Visibility of a coastal area is the following:

$$V = \sum_{1}^{n} \frac{\left[V_C + V_S\right] * \left[0{,}5 + \left(B - D\right) / 2B\right] * \left[1 - \left|z - 0{,}1\right|\right]}{n} \tag{5}$$

The municipality of Milies, part of the prefecture of Magnesia, Hellas, is selected to serve as the case study area (Fig. 1). Its area is 63.8 sq. km and its 'Width' equal to 7,1 km. Beyond to be coastal, this municipality is quite inhomogeneous, in terms of geomorphologic characteristics. Altitude, for example, ranges from the sea level to as high as 1500 meters. Simultaneously, a variety of slopes can be observed there.
The case study is based on the construction of suitable cartographic layers in a geographical information system. The work is based on the raster structure as it is more suitable for modelling. Sea Visibility is estimated for each location in the study area. The basic data are the contour lines, at an interval of twenty meters. The source of the contours is topographic

maps, at a scale of 1/50.000. A ten meters resolution Digital Elevation Model (DEM) is created based on the contour lines. A shaded relief is derived from the DEM to facilitate the comprehension of ground topography. The slope at each location (area-unit) is also derived based on the DEM.

Finally, Sea Visibility is estimated for each location within the municipality of Milies, based again on the DEM. Sea Visibility is calculated based on the creation of straight lines that connect each location to each of the points of interest (sea and shoreline). Subsequently, it is determined whether each line crosses the relief or not. In order to differentiate between locations that have a more open view towards more points of the shoreline or of the open sea, the number of visible points is summed. Consequently, it is not only a matter of the shoreline or the sea being visible from a particular location or not. An estimation of the quantity of the Sea Visibility is also calculated. As an upper bound, the distance of 10 km is set. Passed the 10 km limit, it is assumed that visibility is practically '0' (zero). The value set, i.e. 10 km, is subjective but within reasonable bounds, as it is already mentioned (see section 4.1).

Fig. 5. The cartographic output of the Sea Visibility case study (Milies, Hellas, 2009). On the left, the spatial results of Visibility to the shoreline are illustrated. In center, the spatial results of Visibility to the sea are illustrated. On the right, the spatial results of Sea Visibility as the sum of its two factors are illustrated.

	V minimum value	**V maximum value**	**V mean value**	**Standard deviation**
Distance, D (km)	0	9.02	3.76	2.12
Ground slope, z (tanz)	0	1.67	0.36	0.20
Visibility to the shoreline, Vc	0	1	0.19	0.26
Visibility to the sea, Vs	0	1	0.50	0.21
Sea Visibility, V	0	1.1	0.41	0.26

Table 6. The Sea Visibility case study results (Milies, Hellas, 2009).

A synopsis of the results of the case study is shown in Fig. 5 and in Table 6. In general, the introduced sub-indicator (Sea Visibility) has been calculated without significant problems. All needed data for calculating this indicator are widely available. The final value of Sea

Visibility, concerning municipality of Milies, is equal to 0,41. It is a rather small value, as the Sea Visibility values fluctuate between '0' (zero) and '2' (two).
What is more interesting is the actual use of the indicator introduced. If we can successfully summarize the effect of Sea Visibility in a single value, this paves the way for establishing a typology. The coastal areas can then be classified according to this parameter. It is probably more meaningful to imaging that administrative units or other not autonomous coastal areas can be characterized by this value. The way forward would then be to use the typology as a means to study spatial tensions as Sea Visibility is a major factor attracting human activities.

6. Discussion

Coastal areas are considered as a common good that need to be protected. At the same time, the unstopped natural processes and the very lucrative human activities in this interface between the land and the sea have as result an unstopped transformation of the coastal space. Exploring and managing a dynamic area (as a coastal space is) are very difficult and complicate issues.
The two proposed new indicators do not annul the existed ones. Both, Anthropogenic Intensity and Coastality can act in a supportive and a collaborative manner to accomplish a more precise visualisation of the coastal space.

	CRITERIA / REQUIREMENTS (see 3.2)	ANTHROPOGENIC INTENSITY	COASTALITY
o	Spatial notion	* * * *	* * * * *
o	Local identity	* * * * *	* * * * *
o	Related to total human impact	* * * *	* * *
i.	Exploring and monitoring the coastal areas	* * *	* *
ii.	Enriching spatial planning, in general	* * * * *	* * * *
iii.	Supporting all the involved stakeholders	* * * * *	* * *
iv.	Scientifically robust and useful for governance	* * *	* *
1.	Position	* * * *	* * * *
2.	Geometry	* * *	* * * *
3.	Topography	*	* * * *
4.	Geology	--	*
a.	Clearly defined	* * * *	no, still yet
b.	Representative, relevant and reliable	* * *	* * *
c.	Easy and inexpensive in measuring	* * *	*
d.	Grounded on scientific theory & applicable policies	* *	*
α.	Possibility of future improvement	* * * *	* *
β.	Ability to build a new coastal typology	* * * * *	* * *

Table 7. The new indicators assessment, according to the criteria recorded in section 3.2.

Table 7 illustrates, separately for Anthropogenic Intensity and Coastality, the degree of satisfaction for each criterion mentioned in section 3.2. Undoubtedly is a subjective opinion. A scale of 0-5 stars is used.

Anthropogenic Intensity, (AI), fulfils the majority of the criteria. Indeed, it is of pressure type (according to the P-S-R framework) and it incorporates the spatial notion as it is familiar with parameters like distance and surface. It is able to illustrate with accuracy the local identity. It seems to be very functional for planners, authorities and other stakeholders, as it can provide the total human impact on a coastal area, at local level.
AI is clearly defined with a high degree of representatively and reliability. Based on the case studies, AI has been proved quite easy and inexpensive to be measured. Moreover, because of the previously mentioned advantages, Anthropogenic Intensity can support the building of a coastal typology for small coastal areas (local approach) and in this way it can help the reasonable building of a coastal policy.
Coastality, (C), is not yet fully defined, but it is believed that it can be a very interesting new indicator. The till now related research is very encouraging. Indeed, it incorporates the spatial notion, much more than AI does it. In this way it could be functional for planners and stakeholders, in general. Both the Coastality components can be independent and in this way they can contribute separately to a new typology of coastal areas. It is obvious that everything about Coastality sustains upon the future clarification of the related mathematical formula (3).
The formula used to estimate **Sea Visibility** (V) might be improved in the future by incorporating more parameters or by combining the available parameters in a different way. An important finding of related case study is that the proposed method can be easily applied to similar case studies, preferably in a diverse range of relief formations. This would permit to gain a better insight on the actual meaning of the parameters examined on the ground. An auxiliary method could be to estimate V values for several virtual coastal areas that have ideal shapes.
It is noticeable that indicators like Anthropogenic Intensity and Coastality do not exist nowadays. Both of them are able to support the exploring (with the meaning of analysis) and the monitoring process along the coastal areas in the framework of environmental management. In addition, as they are strongly related to the spatial notion, they are able to make certain several coastal phenomena that they are not yet detectable.

7. Conclusion

The management of the coastal space confronts with the continuous need of reliable data.
The two new indicators support the sustainable ICZM with attention to all coastal space aspects, geomorphology included. Both of them could be in a list of more or less 25 indicators suitable for exploring and monitoring the coastal space.
The ability of Anthropogenic Intensity to be useful for spatial planning procedure and coastal environment management, in general, has been proved. This indicator is suitable to estimate with big precision the total human impact of coastal space.
Further research for specifying the Coastality indicator is needed. The usefulness of Artificial Coastality is obvious and rather easy to be recorded. Natural Coastality could be a very worth instrument (e.g. for real estate market), even if it is yet quite complicated to reach its end definition. Indeed, Natural Coastality could become at local level the representative indicator-identity for a coastal area.
The future research concerning these indicators should attempt to reach a broaden knowledge. Above all, Anthropogenic Intensity and Coastality should try to:

- be adjusted to different geographical scales,

- be adjusted in different areas such as: a) islands and b) lake and river regions
- be adjusted in non Hellenic coasts,
- study the incorporation of parameters for floods, tide phenomena etc.,
- support a new integrated coastal typology.

A very ambitious plan is to look for other (alternative) ways, in the field of spatial planning instruments and methodologies (beyond the present indicators), in order to assess the human impact on the same coastal area. In this way, it is possible to compare the AI results with another "reality".

Alternatively, a less ambitious but tangible objective is the comparison of the values of Anthropogenic Intensity and Artificial Coastality for the same coastal area. This comparison can act as an evaluation test for both the new indicators.

Even more interesting could be the comparison (concerning the same coastal area) of the difference between the Anthropogenic Intensity values during two times, with the difference between the Artificial Coastality values during the same two times. The potential "equal" alteration is obviously a proof that the two new indicators are really valuable.

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12

Geology, Microecological Environment and Conservation of Lonar Lake, Maharashtra, India

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1. Introduction

The Lonar Crater is almost circular depression in the ~65 Ma old basalt flows of the Deccan Traps. Lonar lake (19°58' N; 76°31' E) in Buldhana district, Maharashtra, India is a circular lake (Fig. 1) occupied by saline water. The crater is 150 meters in depth and is absolutely confined from all sides by the walls of the crater and there is not a single channel of water draining away from it, thereby leaving the lake waters stagnant for thousands of years, a large portion of the lake is rather shallow, preserving about 2 meters of water during the monsoon months. Lonar is the third largest natural salt-water lake in the world, with a diameter of 1800 meter. Fredrickson, et al (1973) found that, about 50000 year back a massive meteor entered into the Earth's gravitational forces ranging 60 meter long and weighing 2 million ton. It was racing at a speed of 25 kms per second towards the planet earth. When it struck the earth the energy released was equivalent to that released by six-megaton atom bombs. The impact was so severe that rocks from all sides came on the surface and reached the height of 20 meters.

2. Origin of Lonar lake

The Lonar crater has attracted the attention of world geologists for investigation of its origin and the source of salinity of lake water. Blandford (1868) and Medlicott & Blandford (1879) have suggested the views about the origin of the Lonar, according to them the crater is formed by some phase of volcanic activity. But the work of Beals et al (1960), Arogyaswamy (1962), the evidence of glassy objects near the Lonar crater (Nayak 1972), impact affected minerals maskelynite (diaplectic plagioclase glass) by Venkatesh (1967), Fredrickson et al (1973), Fudalay et al (1980), Nayak (1993), Poornachandra Rao and Bhalla (1999) and Haggerty and Newsom (2001) suggested that the Lonar crater was formed by the impact of a meteorite.
The formation of impact craters is a complex process and depending on the material properties of the target and projectile, parameters of impact, atmospheric effects and on gravity (dePater & Lissauer, 2001; Holsapple, 1993; Melosh, 1989 and Norton, 2002). Simplistically, crater depth and diameter are functions of the energy of impact and the strength of the target material (O'keefe & Ahrens, 1994, Chai, and Eckstrand 1994 and Walsh et al, 2003). For the same energy of impact, the greater the height of the ejecta, smaller is the

depth of the crater since a significant fraction of the impact energy goes into the generation of the ejecta (Walsh et al, 2003). The time of excavation of material from the crater may last for several minutes following the impact, while the amount of impact melt produced is dependent on the abundance of water in the target rocks (Melosh, 1989). Target material below the excavation depth is pushed downwards, whereas the strata above this depth may be pushed upwards (dePater & Lissauer, 2001) as seen in the Lonar crater.

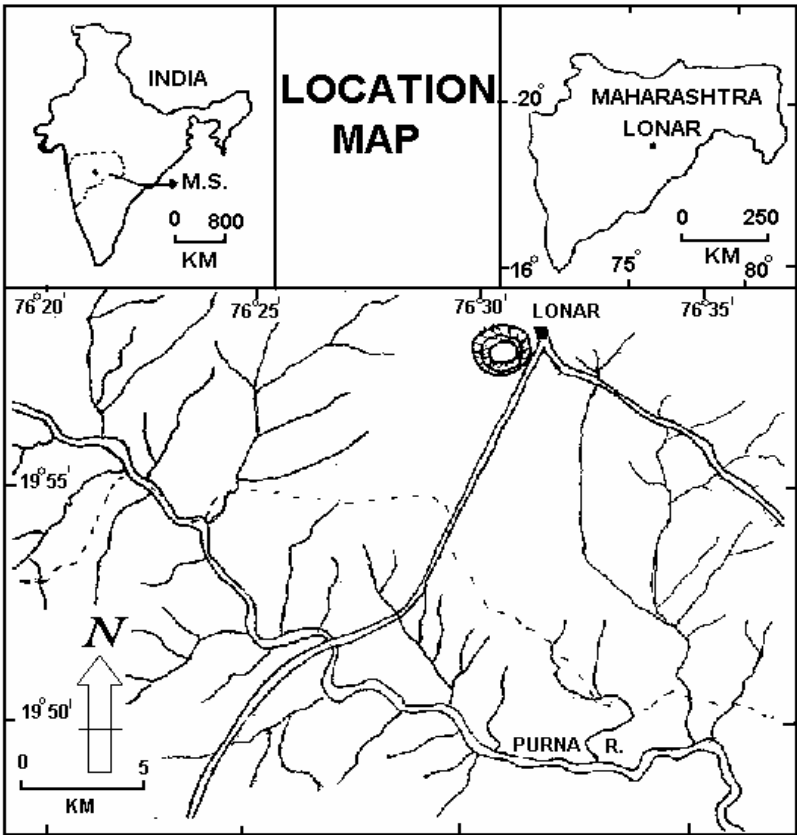

Fig. 1. Location map of Lonar lake.

3. Geology

Geologically, the area belongs to Deccan Basalts of late Cretaceous to early Eocene period (Fig.2). The rocks observed in the lake are compact, vesicular and amygdaloidal basalt. At places the red bole beds separated the two lava flows. The basalt flows dip away from the depression. No appreciable fracturing or shattering is noticeable in the rocks. Compact basalt rocks are highly jointed and weathered around the joints (Fig. 3). The compact basalt also shows the spheroidal weathering in the area.

The Lonar crater has attracted the attention of world geologists and environmentalist for investigation of its origin, biodiversity and the source of salinity of lake water. Regarding the

origin of the Lonar crater, some believed that, it might have been formed by some phase of volcanic activity, but the the evidence of glassy objects near the Lonar crater suggested that the Lonar crater was formed by the impact of a meteorite. The impact origin of the Lonar Crater has been well established based on the evidence of shock-metamorphosed material. Coarse breccias with shatter cones and maskelynite-bearing microbreccia have been reported in drill core samples from the crater floor indicating the impact origin of the crater (Fredrickson et al, 1973). Glassy objects of varying sizes, up to 50 mm in diameter and resembling impact melts, have been recovered from the surrounding ejecta blanket (Nayak 1972).

Thermoluminescence dating of selected impact spherule/melt samples suggests that this crater was possibly formed ~52± 6 kyr ago (Sengupta et al, 1997). The crater is 1830 m in diameter and a shallow saline lake, ~7 m deep (Nandi & Deo, 1961), occupies the crater floor. A 20 m high raised rim around the lake (Fredrickson et al, 1973 and Nayak 1972) formed by both the uplift of the target layers as well as deposition of impact breccias. Coarse as well as microbreccia have been recovered in drill cores from depths of ~350 m beneath the floor of the lake (Fredrickson et al, 1973). A smaller circular depression called Little Lonar, 300 m in diameter and located about 700 m north of the main crater, has been suggested to be a second impact crater. The Little Lonar is thought to have formed either by impact of the throw out from the main crater or by direct impact of a smaller fragment of the main bolides (Fredrickson et al, 1973 and Master et al 1999).

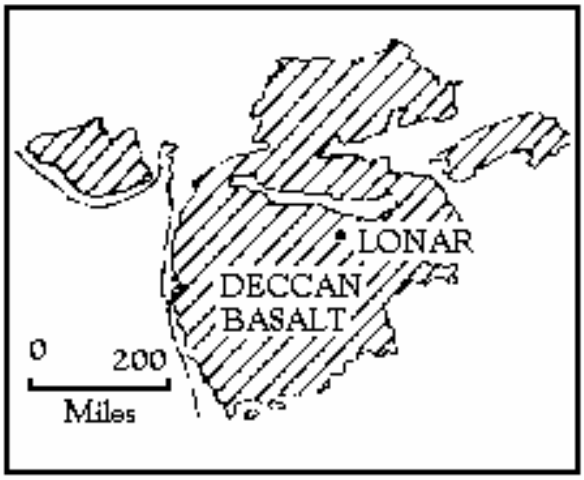

Fig. 2. Geological Map of Deccan volcanic Province

The maximum thickness of the Deccan traps in the Lonar crater region is estimated to be between 400 and 700 m (Subbarao, 1999 and Subbarao et al, 1994). In this region, there are six lava flows, ~8-40 m thick, exposed in and around the Lonar crater, of which the lower four flows are exposed along the crater wall (Ghosh & Bhaduri, 2003). The flows are separated from each other by marker horizons such as thin paleosols, chilled margins, and vugs with secondary mineralization (Ghosh & Bhaduri, 2003). Individual flows are often difficult to characterize because of vegetation and surface weathering features. The lava flows in the Lonar crater margin are upturned and dip away from the crater edge at inclinations of 14° to 27° (Fredrickson et al, 1973 and Fond & Dietz, 1964). Fresh, dense basalts are exposed only in

the upper 50 m of the crater wall below which the flows are weathered and friable (Fudali et al, 1980). The impact melts occur within the ejecta blanket (Fig. 4) found around the Lonar crater, which are seen to extend up to 1600 m from the crater rim (Ghosh & Bhaduri, 2003). The ejecta consist of two contrasting types of debris. The bulk of the ejecta is crudely stratified and shows no evidence of shock. The other types of debris in which clasts from different bedrocks are mixed show the evidence of varying degrees of shock (Fredrickson et al, 1973). These two units of the ejecta are similar to the so-called 'throughout' and 'fallout' units as identified in other simple craters (Shoemaker, 1963).

Fig. 3. Jointed compact basalt exposed in the rim of the Lonar crater at the spring.

The gravity and magnetic anomalies of Lonar lake suggests that the impact has modified the magnetization vector and density of the country rock (Deccan trap) up to about 500–600 m below the surface with a brecciated part of about 135 m of bulk density of 2.60 g/cm3 and fragmented layer of about 150 m of bulk density 2.7 g/cm3 with induced magnetization. This is explained through the 3D view of affected part of Deccan trap due to impact computed from gravity anomaly of the Lonar lake (Fig. 5). The google image of the lake is given Fig. 6.

4. Materials and methods

For the present paper water samples were collected from five different sampling stations in airtight and opaque polythene container. From these five samples four samples (A to D) are located in the reservoir and one sample station (E) is the fresh water from influent spring called Dhara (Fig. 7). Water samples were analysed for physico-chemical parameters such as dissolved oxygen (DO), turbidity, pH, Chlorides (Cl), total hardness (TH), total dissolved Solids (TDS), Ca, Mg, Na, K, CO_3, HCO_3, SO_4, BOD and COD (Table 1). DO and pH were measured in the field with necessary precautions. Remaining parameters were analysed by following the methods given by APHA (1989). Microbial examinations were carried out using the standard procedures given by (APHA 1989 and Trivedy & Goel 1986) and the results were compared with maximum permissible limits of BIS (1991).

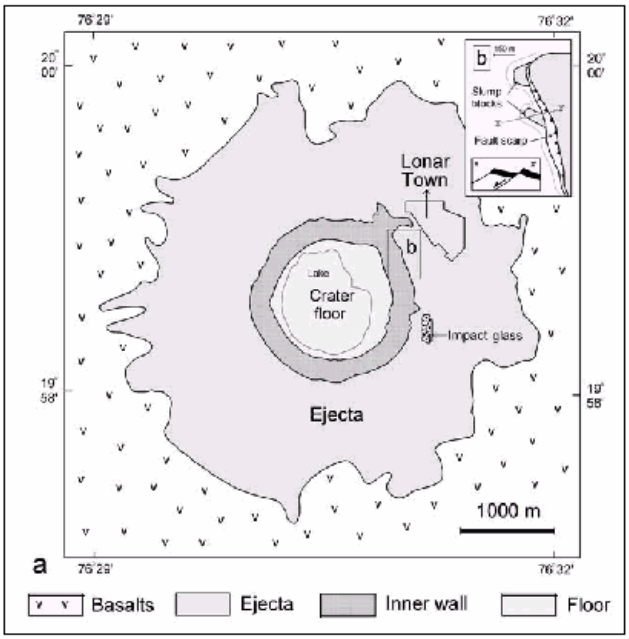

Fig. 4. (a) Geological sketch map of ejecta at Lonar crater (After Ghosh & Bhaduri, 2003 and Senthil Kumar, 2005). A massive basalt flow is well exposed on the upper crater wall, and the underlying flows are covered by basalt debris, soil, and vegetation. Impact melt fragments and spherules are found in the clayey alteration products of the ejecta materials, and one such occurrence is shown in the map. (b) A sketch map of normal faulting in the north-eastern part of the inner wall.

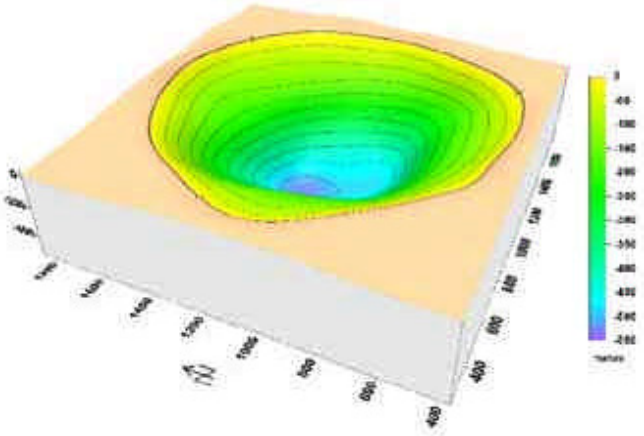

Fig. 5. A 3D view of affected part of Deccan trap due to impact computed from gravity anomaly. It suggests a maximum depth of 500 m of affected part due to impact (After Rajasekhar & Mishra, 2005).

Methods of sampling of microorganisms

1. **Sample Collection**

Algal blooms and water samples were collected in and around four different spot in the Lonar Lake.

2. **Culture media used**

The media employed for isolation of *Spirulina sp*. in Zarrouk media with pH 10.5
Zarrouk medium (Table 1)

Composition	g/l	Composition	g/l
$NaHCO_3$	16.8	$CaCl_2$	0.04
K_2HPO_4	0.5	$FeSO_4.7H_2O$	0.01
$NaNO_3$	2.5	EDTA	0.08
K_2SO_4	1.0	*Solution A5	1 ml
NaCl	1.0	*Solution B6	1 ml
$MgSO_4.7H_2O$	0.2	_ _	_ _
***Solution A5**			
H_3BO_3	2.86	$CuSO_4.5H_2O$	0.079
$MnCl_2.4H_2O$	1.81	MoO_3	0.015
$ZnSO_4.7H_2O$	0.222	_ _	_ _
***Solution B6**			
NH_4VO_3	22.96	$Na_2WO_4.2H_2O$	17.94
$KCr(SO_4)_4$ $12H_2O$	192.0	$TiOSO_4H_2SO_4.8H_2O$	61.6
$NiSO_4.6H_2O$	44.8	CO $(NO_3).6H_2O$	43.98

Table 1. Composition in g/l of cultural media used for analysis.

Fig. 6. The Google image of the lake

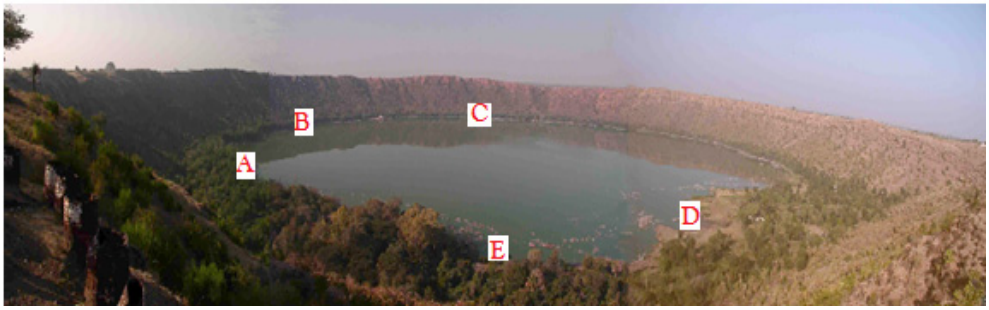

Fig. 7. View of Lonar Lake with Location of water sample sites (Lake water A-D and spring (Dhara) water E).

3. **Enrichment of samples**

The water samples are labeled as A, B, C and D and are enriched with both media in 500 ml flasks containing 250 ml media. The flasks were inoculated at room temperature 25° ± 2° C with continuous illumination of 1500 lux provided with white fluorescent lamps for two weeks.

4. **Isolation**

After second enrichment the 5% inoculum size was spread on solid media containing 2% agar. The plates were incubated at room temp 25°C with continuous illumination of 1500 lux provided with white fluorescent lamp. This procedure is repeated thrice to bring unialgal culture and can be obtained using single cell isolation. The flasks were hand shaken twice daily. The isolates were chosen according to difference in their morphological nature with in microscopic view.

5. **Pure Culture and Maintenance of Lonar Isolates**

Pure cultures are obtained using Single Cell Isolation Technique. Cultures were routinely maintained in sterilizing cotton plugged conical flasks in a culture room maintained at 25°C and illuminated under a fluorescent light intensity weekly to fresh media to keep the algae in logarithmic growth phase for use in the experiments.

Studies on Lonar lake water and distilled water with addition of N, P, K and rock-phosphate in growth medium on *Spirulina* isolates

The water collected from Lonar lake and water sterilized by autoclaving at 15 lbs for 20 min. Media with various combination of Lonar water, distilled water, N, P, K and rock-phosphate were prepared and sterilized by autoclaving at 15 lbs for 20 min. Five percent inoculum of *S. fusiformis* and *S. patensis* were inoculated into 500ml sterilized autoclavable PVC Conical flasks containing 250 ml media and grown at room temp at 25°C with illuminating under a fluorescent light intensity of 1500 lux for 14 hrs / day . Flasks were hand shaken twice daily. The pH of media is same i.e. 10.5 adjusted. The all media are in duplicate. Growth was followed at 3 days intervals by measuring the optical density at 640 nm. Every time 50 ml of culture was removed from the each media and used for analysis of pigments and growth study.

5. Hydrochemistry

The physicochemical parameters of lake water samples analyzed includes pH, Chlorides (Cl), total hardness, total dissolved Solids, Ca, Mg, Na, K, CO_3, HCO_3, SO_4, etc. (Table 2). The comparative values of these parameters from earlier researchers are given in Table 3.

The most striking feature of the lake water is its extreme salinity and high alkalinity. The pH reaches the mark over 10.5 when tested with a portable pH meter. The pH was in the range of 10.5 to 11.2 for lake water and 7.9 for the influent spring water samples. The higher values of pH may be due to the increased primary production in aquatic ecosystem of lake (Zafar, 1996 and Mohd. Mussaddiq et al, 2001) and also the high rate of photosynthetic activity will raise the pH (Parkins 1967). Dissolved oxygen (DO) ranged from 0.03 to 0.09 mg/l indicating the anaerobic conditions in the lake water. Low rate of primary production in aquatic ecosystem of lake is also indicated by the low values of BOD and COD that ranged from 0.2 to 0.7 mg/l and 0.01 to 0.04 mg/l respectively. The perennial nature of the lake may be due to this high alkalinity, so that, as evaporation proceeds, the concentration of the dissolved alkaline matter is increased and, in due course, the evaporates begin to separate out, which gradually form a more or less continuous scum over the surface of water, thereby considerably retarding the rate of subsequent evaporation.

As regards Total Dissolved Solids (TDS), the BIS (1991) maximum permissible limit is 1500 mg/lit for drinking water. The values of TDS in the Lonar lake water ranged from 13240 mg/lit to 16280 mg/l (Table 2), which are very high and well above the maximum permissible limit of BIS (1991) and (WHO 1992). The salinity of the water ranged from 8760 to 10540mg/l indicating that the water is highly brackish.

Sr. No.	**Parameters**	**BIS (1991) maximum permissible limits**	**Sample No. A**	**Sample No. B**	**Sample No. C**	**Sample No. D**	**Sample No. E**
1	pH	6.5 – 9.2	10.2	11.2	10.5	10.5	7.2
2	Conductivity µS/cm	- -	18545	20520	19650	18960	780
3	TDS mg/l	1500	13240	16280	14612	14205	421
4	DO mg/l	- -	0.03	0.09	0.06	0.05	0.02
5	BOD mg/l	- -	0.2	0.7	0.3	0.3	0.1
6	COD mg/l	- -	0.01	0.02	0.04	0.03	0.01
7	Alkalinity mg/l	200	4112	4736	4390	4260	370
8	Salinity mg/l	- -	8760	10540	9970	9630	125
9	Chloride mg/l	1000	4883	5630	5150	4970	60
10	Ca mg/l	200	1365	1649	1510	1470	32
11	Mg mg/l	100	654	924	780	725	36
12	SO_4 mg/l	400	154	185	172	167	19
13	NO_2 mg/l	45	10	18	13	12	05

Table 2. Physico-chemical parameters of Lonar Lake water samples.

The Chloride concentration in the lake varies from 4883 to 5630 mg/lit which is well above the possible limit of 250mg /lit as given by BIS (1991). This means that the water is polluted due to organic matter and the other waste in the water. Total Alkalinity is the measure of the capacity of water to neutralize a strong acid. The alkalinity in water is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, together with hydroxyl ions in free state. Alkalinity less than 250 mg/lit is desirable for domestic purpose. Alkalinity values of lake water at different sampling stations (i.e. 4112 to 4736 mg/lit, Table 2) are

much greater; from this it can be inferred that the lake water is highly alkaline and it is ascribed to an interaction between sodium chloride, calcium carbonate and water stagnate over a long period of time (Malu 1999, Malu et al, 1998 and Mohd. Musaddiq et al 2001). The values of Ca (1365 to 1649 mg/lit) and Mg (654 to 924 mg/lit) are found to be very high. Hence the water is very hard and not free from pollutants in it. As the lake water is characterized by very high concentration of chlorides, calcium and magnesium so the total hardness of any water is dependent on these factors (Jain et al 1997).

Natural water contains higher levels of sulphate contributed from the rock weathering. In addition to this domestic waste, sewage and industrial effluents also add sulphate to aquatic ecosystem there by increasing organic pollution. The sulphate content in the present area is less i.e. 154 to 185 mg/lit in the lake water sample and very less in the spring water i.e. 19 mg/lit (Table 2). The nitrate content of the lake water is also low (10-18 mg/lit) as compared to the value of nitrate of spring water i.e. 5 mg/lit (Table 2).

Parameters	After Chaudhary and Handa, 1978				After Muley and Babar, 1998			
	Lake water	Dhara spring water	Sitanahani spring water	Ramgaya spring water	Lake water	Dhara spring water	Sitanahani spring water	Ramgaya spring water
pH	9.8	7.2	7.3	7.5	10.7	7.6	7.4	8.1
TDS	16170	1200	382	543	15890	986	401	497
CO2	2547	- -	- -	- -	2873	4	12	7
HCO3	1876	345	358	365	1629	97	312	377
Cl	5505	460	12	41	6123	183	25	53
SO4	129	67	4.8	14	1.38	23	3.9	8
NO3	6.1	409	13	82	7.3	138	41	63
Ca	8.9	125	33	45	10.7	73	21	34
Mg	13	97	36	43	14	59	32	41
Na	6252	92	47	75	7324	61	21	39
K	15	3.6	0.7	1.7	17	2.3	1.2	1.9

Table 3. Comparative values of physico-chemical parameters of lake water (After Chaudhary and Handa, 1978 and Muley and Babar, 1998)
All concentrations in ppm except pH

6. Microecological environment

In the present study the species of bacteria related to water borne diseases were also found in higher proportion indicating the non-potable nature of the lake water but the spring water is normal and free from bacteria. Microorganisms like *Arthospir*a and other micro algae are predominant as primary producer are present along with alkaline bacteria and fungi. Studies on the specialized micro-ecology revealed greater cognizance of these microbial forms in environmental, healthcare and industrial biotechnology. In the present investigation to understand in depth microechological status of such extreme alkaline environment presence of various types of microorganisms were recorded including Bacteria viz. *E. coli, S. aureus, Streptococcus sp., V. cholerae, V. haemolyticus, Bascillus sp. Klebesiella Sp., Ps. Aeruginosa, Methanococcus Sp.* and *azatobacter,* Algae i.e.*spirulina*, *clasterium, Blue green Algea (Cyanobacteria)* and *chlorella* and Fungi viz. *A. niger and Fusarium Sp.* Algal blooms and

water sample were collected from the four selected sites in the lake and a spring water sample. Samples were enriched by using Zarrouk medium with adjusting the pH of the medium to 10.5 for isolation of alkaline *spirulina* sp. Three different unialgal culture were obtained using a single cell isolation technique and their morphological nature within microscopic view studied and revealed are: i) *Spirulina platensis* (*Nordst.) Gomont,* ii) *Spirulina subsalsa Oersted and* iii) *Spirulina major kutz. Ex. Gomont.* Occurrence of few species of algae and fungi indicate the characteristic nature of bioflora, which needs the further investigations and interpretation.

The composition of the Lonar water is of the $Na_2CO_3HCO_3Cl$ type. Regarding the origin of salinity and alkalinity of Lonar lake water it is argued that the evaporation of the lake water in the absence of the drain was responsible for the alkalify of the lake waters (Blandford, 1868). Lake Alkalinity is also due the conversion of sulphate ion to carbonate through the intermediate formation of 32 sulphide. All these characteristics of lake resulted into an extreme alkaline ecosystem with all different microbial type prevailing in and around the lake. Microorganisms like *Arthospir*a and other micro algae are predominant as primary producer are present along with alkaline bacteria and fungi. The results of microbiological analysis are given in Table 4.

Three different unialgal culture were obtained using a single cell isolation technique (Hoshow and Rosowski, 1975) their morphological nature within microscopic view studied and revealed:

1. ***Spirulina platensis*** (*Nordst.) Gomont*, as blue green spirals are more or less regularly coiled showing constricted cross walls with spiral and trichome breadth 57.12 and 8.92 respectively having spiral distance of 18.75 in microns,

2.*Spirulina subsalsa* *Oersted* a blue green spiral are regularly coiled or some times loosely coiled showing no constricted cross wall with spiral and trichome breadth 2.15 and 3.22 respectively and spiral distance of 5.35 in microns and

3. *Spirulina major* *kutz. Ex. Gomont* a blue green regularly spiraled coiled no constricted cross walls with spiral and trichome breadth 3.57 and 1.43 respectively and spiral distance of 3.57 in microns.

These isolate possess variations in their morphological characteristics as shown below (Fig. 8, plate 1, 2 and 3). Thus these organisms appear to be capable of adaptation to very extreme habitat and colonize in these type environments predominantly in which life for other microorganism is, if not impossible, but very difficult. Similar investigations showed the population of alkalophilic *S.platensis* of certain alkalophilic lakes in Africa and *S. maxima* of Lake Texcoco in Mexico In some of these lakes *Spirulina* groups as a quasimonoculture. In these African lakes in the Chad region (Iltis, 1971) has conducted an extensive survey of the phytoplankton of alkaline lakes. Species of *Spirulina* have been reported for instance from tropical waters to North Sea, thermal springs (Anagnostidis and Golubic 1966), salt ponds (Golubic, 1980).

Lonar Lake is a hyper saline environment due to presence of higher concentrations of various salts in lake water (Chuodhary and Handa, 1978; Badve et al. 1993 and Muley and Baber, 1998). The characterized salt concentration could be major reason of predominant population of cynobacteria such as *Oscillatoria*, *Synechocystis, Anabaenopsis* and *Spirulina* in the lake. It is confirmed that the cynobacterial population is regulated by the concentration of salt and become monospecific (Iltis, 1968; 1969). Hence, population of *Spirulina* is considerably more in Lonar water body representing the optimal concentrations of salts and alkalinity. An analogous situation appears to exist in the alkaline lakes of the Rift Valley in

East Afr*ica.* These lakes too are also characterized by very high pH values close to 11, and high salt concentration, particularly sodium carbonates originating from the sedimentary volcanic deposits as in Lonar Lake.

Sr. No.	Name of Microorganisms	Sample No. A	Sample No. B	Sample No. C	Sample No. D	Sample No. E
Bacteria						
1	E. coli	+	+	+	+	—
2	*S. aureus*	+	+	+	+	—
3	*Streptococcus sp.*	+	+	+	+	—
4	*V. cholerae*	+	+	+	+	—
5	*V. haemolyticus*	+	+	+	+	—
6	*Bascillus sp.*	+	+	+	+	—
7	*Klebesiella Sp.*	+	+	+	+	—
8	*Ps. Aeruginosa*	+	+	+	+	—
9	*Methanococcus Sp.*	+	+	+	+	—
Fungi						
1	A. niger	+	+	+	+	—
2	*Fusarium Sp.*	+	+	+	+	—
Algae						
1	*Chlorella Sp.*	+	+	+	+	—
2	*Clasterium*			+		—
3	*Blue green Algea (Cyanobacteria)*	+	+	+	+	—
4	*spirulina sp.*	+	+	+	+	—

+ Present, — Absent

Table 3. Microbial (bacterial), algal and fungal diversity of Lonar Lake water.

In some of the lakes, such as Nakuru, Elenenteia and the Crater Lake in which pH range from 9.4 to 11 *Spirulina platensis* and *S platensis var. minor* are predominant microorganisms present (Jenkin, 1936 Blum, 1976 and Anusuyadevi et al, 1981). Therefore, in such lakes cyanobacteria would represent more than half of the phytoplankton population. The correlation existing between salt concentration and abundance of *Spirulina* was confirmed in study on groups of lakes characterized by a salt concentration of 5 to 14 g/l (Iltis, 1971). In addition in such lakes wide fluctuations noted in the relative abundance of *S.platensis* depends on the seasonal changes during the year. Two crater lakes in Ethiopia, Lake Kilotes and Aranguadi bears micro ecological similarity with Lonar lake as both characterized by a high salt content and an alkaline pH, support a dense population of *Spirulina* (Tallings, 1973). Lake Arangudi is more similar in characteristics with Lonar lake as alkaline pH ranging near to 10.3 to 10.5 and predominance of *S. platensis* resulting in waters appears deep green. There appearance of high concentrations *Spirulina*, which is an indicator of extremely high photosynthetic, rates showing 1.2 to 2.4 g of oxygen produced/sq. meter/h.
In view to assess the possible biogeochemical effect of Lonar lake water exerted on cyanobacteria and ultimately on micro ecology of lake more investigations were carried out with growth medium using Lonar water as solvent in various eleven combination with different concentrations of N.P.K. and Rock phosphates (g/l) on the same microorganism i.e. *Spirulina* Comparative analysis involving the growth and development of Caretenoids,

Phycobiliproteins , Total chlorophylls in Lonar *S. platensis* isolate and indigenous *S. fusiformis* isolate as a counterparts were conducted. Addition of rock phosphate with Lonar water used culture media showed beneficial effect on growth rate *S. platensis* and *S. fusiformis.* When results were interpreted in terms of Lonar water used combination interestingly, *S. platensis* showed advantageous effect on productivity of total chlorophyll, caretenoids and phycobiliproteins (phycocynin, allophycocynin and phycoerythrin) while indigenous *S. Fusiformis* could show highest productivity with use of distilled water in combination. Results indicates that Lonar crater's distinguished geochemical status sustains different cynobacterial and phytoplankton population altogether.

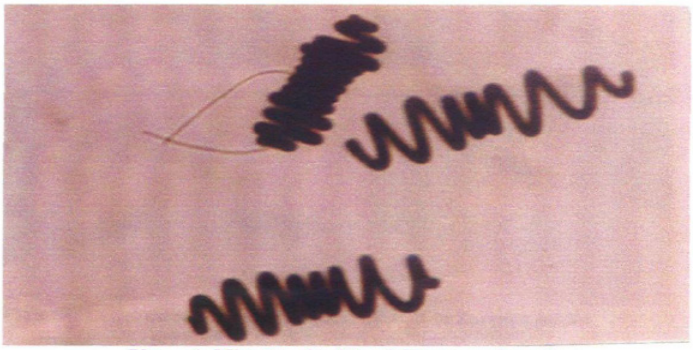

Plate : 1. Microscopic view of *Spirulina platensis.*

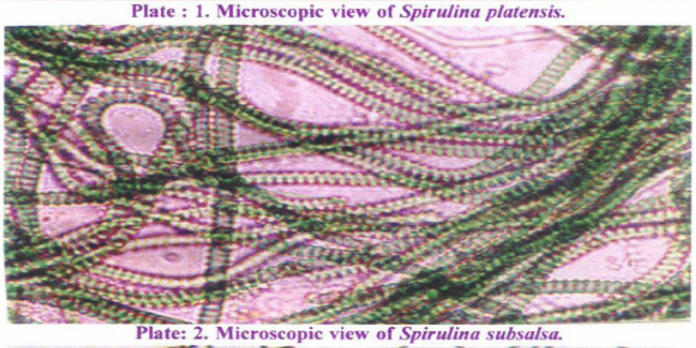

Plate: 2. Microscopic view of *Spirulina subsalsa.*

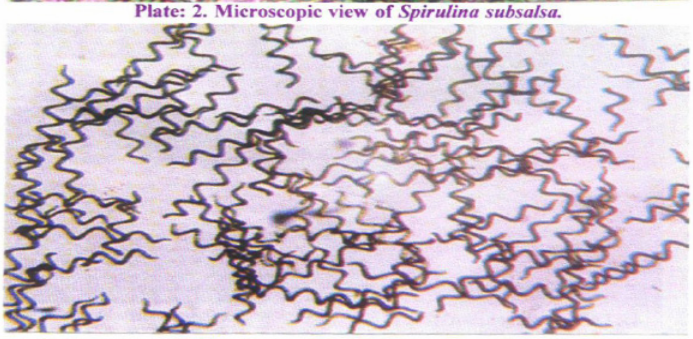

Plate: 3. Microscopic view of *Spirulina fusiformis.*

Fig. 8. Plate 1 – Microscopic view of *Spirulina platensis,* Plate 2 – Microscopic view of *Spirulina subsalsa* and Plate 3 – Microscopic view of *Spirulina fusiformis*

7. Conservation of Lonar lake

The most striking feature of the crater-lake is the high concentration of salts like sodium chlorides, carbonates, bicarbonates and fluorides, which come from the small streams joining the crater. As the water does not drain away these substances get collected beneath the surface. The lake shows high alkalinity (pH 10.5 to 11.2 Table 2), while the spring water is sweet and potable water with neary a neutral pH 7.2. The presence of the crater in a monotonous, arid terrain has caused localized transition in geographical, climatic and ecological parameters. Being a confined subterranean hollow, closed from all sides, the crater is protected from heavy winds, has high humidity and forms a localized temperature system partially screened from direct sunlight at places. An eco-system has evolved within the lake with the evolution of various microorganisms (Arthorospira, Spirullina, Closterium, Chlorella, Eudorina and Ankistrodesmus), bacteria and algae's, which are in abundance especially, near the side of the lakes and capable in enduring high salinity levels. It has been reported that there is a record of about 114 types of algae and distinct layers of dried algae, green algae and newly forming algae. Apart from these algae the lake is also rich in both flora and fauna. Trees of custard apple, eucalyptus, lemon grass, bamboo and teak are found. The savannah woodlands bordering the lake along with the shrubs, herbs and climbers host a wide range of animals including squirrel, monkeys, barking deer, mongoose, black-napped hare, bats, monitor lizard, snake and insects like spider and scorpion. Avian life is represented through resident and migratory birds like egret, pond heron, tailor bird, barn owl, grey hornbill, bush quail, white-necked stork, flamingo, lapwing, grey wagtail, golden oriole, crane, black-winged kite, Indian peacock, peafowl, magpie, robin, etc.

An ever-increasing population coupled with urbanization has lead to an indiscriminate invasion of human activities in Lonar. Construction activities and overcrowding of slums have affected the crater. Many streams in the rim area are polluted from regular domestic requirements such as bathing and washing using non-biodegradable detergents were dumping in these pollutants previously in the lake (e.g. Nabbi Nala stream). The streams are now diverted from the lake. Around 52 acres of land, at the base of the crater, containing a perennial spring and supported by abundant groundwater is under agriculture. Traditionally, the agricultural landholdings seemed to have affected the crater little as all land owners resided in the town and not inside the crater. However, presently, the same activity has threatened the crater soils and lake from the introduction of synthetic fertilizers, pesticides and insecticides as by-products of modern agriculture. The toxic chemicals have altered the chemical characteristics of soil and threatened the lake micro-flora to subsequent extinction. Since the lake is a captive water body, the concentration of chemicals has been on the rise causing irreversible pollution. Motorized lifting of water from the crater-lake has caused imbalances in the natural hydrological cycle. Extraction of salts and geological materials have disturbed the chemical constitution of the lake and led to the misuse of valuable resources. Other negative impacts have been from uncontrolled livestock grazing, firewood collection and occasional hunting of birds. Deforestation has damaged ephemeral plants and caused imbalances in the population and frequency of floral species. The dense natural mixed-deciduous forests, which once covered the entire basin and crater slopes providing natural refuge to animals exists, have become sparse. During 1986-91, the Forest Department sanctioned funds for afforestation within 200 acres of the crater with neem, teak, gulmohar and bamboo saplings. Unfortunately, a negative fall-out of this extensive

programme was the plantation of the exotic prosopis juliflora (wild babul) leading to the growth of thorny inaccessible thickets around the crater-lake. Moreover, the foliage and fruits being ejected by the excreta of cattle spread its growth at an alarming rate gradually replacing the crater's natural vegetation and becoming an absolute menace. The rising water levels of the lake are attributed to the sewage flowing into the lake which is submerging the surrounding vegetation and corroding the temples.

The crater ecosystem can retain its unique character with immediate controls put in place through an integrated plan. For detailing the conservation and management plan, the following steps need to considered: (a) identification of the geographical area to be conserved; (b) identification of an appropriate legal status to be accorded; (c) formulation of procedures for operation; and, (d) a monitoring mechanism to review and guide the process. The Government and Non-Governmental Organizations (NGOs), voluntary agencies and institutions working towards conservation would be essential to prevent any negative fall-outs on the crater-lake. It would also be necessary to take cognizance of suggestions and complaints related to policy issues.

A large number of slum dwellers perform ablutions on the roads making them filthy. To reduce water pollution, all detergents could be banned in the Dhara the spring water complex. Similarly, garbage accumulation should be completely restricted by law. The complete protection of the ejecta blanket from agricultural activities is crucial. A ban should be imposed on the use of toxic materials as pesticides and fertilizers in the agricultural fields inside the crater. Trees and shrubs on the crater floor are being cut at an alarming rate. The deforestation and grazing activities inside the crater should be completely stopped. In order to the ecological restoration, it the vegetal cover should be improved on a large scale so that this can function as a natural buffer zone for protecting the crater ecosystem. The microflora of the crater-lake shows high degree of specialization among floral components of the ecosystem with huge economic potential for research and development.

The Lonar crater-lake should be given special status to protect and conserve its natural heritage of extraordinary significance. The area in and around the crater declared as a National Park. This will facilitate the Forest Department to exert protection and ensure effective conservation of the crater eco-system. With social justice being inevitably linked with conservation, it is important to safeguard the interests, customs and traditions of the indigenous people. Local authorities should develop a mechanism allowing all sections of the society to be partners in planning and ensure equitable share in the costs and benefits. The cultural heritage involving important values and sensitivities of the religious communities, geo-physical characteristics of the eco-system, indigenous species of diverse flora and fauna and existence of the institutional structure within which these elements coexist need to be interwoven.

8. Conclusion

Geologically, the area belongs to Deccan Basalt formations of late Cretaceous to early Eocene period. The occurrence of impact of meteorite yielded the rare mineral called the *muskelynite* (impactite mineral) indicating that the lake is of meteorite impact origin. All the physicochemical parameters of water including pH, Chlorides (Cl), total hardness, total dissolved Solids, Ca, Mg, Na, K, CO_3, HCO_3 and SO_4 are higher and very greater than the BIS (1991) and WHO (1992) maximum permissible limits for drinking and other domestic

use of water. The presence of species of bacteria related to water borne diseases were also found higher indicating the non-potable nature of the lake water but the spring (Dhara) water is normal and potable. Occurrence of few species of algae and fungi indicate the characteristic nature of bioflora, which needs the further investigations and interpretation. The assemblage of geological and micro-ecological attributes of Lonar lake water makes it very interesting for researchers.

The saline crater-lake is a great storehouse of unique floral and faunal assemblages with its unique ecosystem having evolved due to its unusual hydrogeological and climatic conditions. Unplanned expansion of Lonar town characterized by unrestricted construction activities, overcrowding of slums and inadequate civic amenities and faulty infrastructure projects have endangered the crater system and hence should be avoided. The crater slopes have succumbed to soil erosion and denudation from uncontrolled grazing and overgrowth of Prosopis Juliflora. Agricultural activities have altered the texture of the crater floor and soil character. Water pollution from release of toxic substances has changed the chemical composition of the lake, lead to the extinction of flora and affected the already dilapidated temples and archaeological monuments in the lake precincts. The lake urgently needs to be accorded immediate protection and special legal status and saved and preserved for future generations to come.

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