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THE BENEFITS FROM ENVIRONMENTAL REMEDIATION

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Abstract

Environmental remediation projects inevitably take place against a backdrop of overall social goals and values. These goals can include, for example, full employment, preservation of the cultural, economic and archaeological resources, traditional patterns of land use, spiritual values, quality of life factors, biological diversity, environmental and socio-economic sustainability, protection of public health. Different countries will have different priorities, linked to the overall set of societal goals and the availability of resources, including funding, man-power and skills. These issues are embedded within both a national and local socio-cultural context, and will shape the way in which the remediation process is structured in any one country. The context will shape both the overall objectives of a remediation activity within the framework of competing societal goals, as well as generate constraints on the decision making process.
Hence, the overall benefit of a remediation project is determined by its overall efficiency and effectiveness within the given legal, institutional, and governance framework, under the prevailing socio-economic boundary conditions, and balancing technology performance and risk reduction with fixed or limited budgetary resources, and is not simply the result of the technical remediation operation itself.

1. INTRODUCTION

The overall objective of remediation in an intervention situation is to minimize negative environmental and health impacts, including exposure to radiation [1]. These objectives can be met by a variety of technical and management measures, and any combination thereof.

Environmental decision making will always take place against a backdrop of overall social goals and values. These goals can include, for example, full employment, preservation of the cultural, economic and archaeological resources, traditional patterns of land use, spiritual values, quality of life factors, biological diversity, sustainability (both in the environmental sense [4] and in a socio-economic sense), and protection of public health. There is a strong link between the overall set of societal goals and the availability of resources, including funding, man-power and skills. The added benefit from maintaining or improving employment rates is particularly relevant for IAEA Member States with economies under pressure.

The IAEA is addressing these issues in a forthcoming technical document entitled: "Non-Technical Factors Impacting on the Decision Making Processes in Environmental Restoration-Influences on the Decision Making Process, such as Cost, Planned Land Use, and Public Perception".

It must be understood that resources spent on remediation activities are typically not available for use in achieving other goals of the society. Their availability, therefore, may be controlled by priority setting within the society:

"*Society must distinguish between significant and trivial risks. ... When money and resources are wasted on trivial problems, society's wealth and hence health is harmed*" (Bruce Ames, University of California, Berkley as quoted in [2]).

The balancing of the various goals of social policy is often handled in a political context which specifies the level of resources available for remediation. As in many cases, and in particular so when the government has assumed responsibility for 'orphan' environmental contamination's, the spending of public money is involved, it is probably fair to expect that the overall benefit from its expenditure be maximised and the potential for other dividend is increased. There will be however pre-determined constraints, such as overriding principles for health protection or the maximum amount of resources available.

SOCIAL GOALS AND VALUES

Environmental and socio-economic sustainability

Sustainability, as an overarching social value, is becoming an increasingly significant issue in environmental and economic decision making. Sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [4], although many critics have argued that sustainable development is an unachievable goal. Sustainable development therefore requires reconciliation between improving the conditions of life in an equitable way, now and in the future, and in the long-term conservation of the natural environment, which supplies the resources on which development is founded. Sustainability, however, should not be restricted to ecological aspects, but should encompass the socio-economic foundations of society as well.

Hence, when environmental remediation strategies are being developed, decisions should be based on an understanding of affected peoples' values [3], interests and priorities. These priorities may vary considerably as a function of the socio-economic circumstances. Thus priorities may be set quite differently in developed, emerging and developing countries.

Ownership and Social Identity

Even though the customary level of community participation in decision making varies significantly from country to country, local communities still play an important role in providing the context for decision making. A community is formed on more than the natural ties of kinship; implicit in the term are: the sense of territory, a considerable degree of interpersonal acquaintance and contact, and some special bases of coherence that separate it from neighbouring groups. Traditionally, communities have been based on ascriptive identities developed over long periods of time and patterns of loyalty. In many countries, and not only in the Western World, 'new communities' have emerged in recent years as strong players in the collective bargaining process of environmental interventions. These new communities are 'communities of place and interest', a means of delivering a decentralized welfare state and regional economies, and have emerged in the pursuit of individual interests. In other words, they are often autonomous associations that exist independently of the State. They include all forms of collectivities, associations, non-governmental agencies etc.

Previously, affected communities were generally considered to be restricted to those local to, or directly affected by the implementation of a development or proposal. Deliberation and decision analysis therefore was typically restricted to those parties with a recognised claim and vested interests. However, the emergence, and impact, of well-organized and-funded non-governmental (environmental) organisations (NGOs) in recent years has been significant. NGOs are not limited to environmental groups; the paralleled increase of industries' (lobbying) associations has also led to significant changes in the number and scope of interest parties potentially involved in decision making.

Local socio-economic conditions

Failure to consider local conditions can derail a remediation process in a variety of ways. For example, a remediation plan may not be accepted by the local community, either through tacit and private non-compliance or open resistance by e.g. the formation of citizen groups, depending on local traditions of governance. Particularly when institutional measures are part of the overall remediation strategy, solutions may fail when local behaviours are not considered adequately. Decisions may be judged inappropriate when they interfere with local practices and customs.

The structure of the local economy may be significant in framing the objectives of the remediation activities. Remediation in an industrialized region may focus, for example, on issues such as employment and economic re-use of lands; in a region with a primarily rural 'traditional' economy, emphasis on avoiding disturbances to indigenous cultural conditions may be paramount. A prolonged contamination situation and ensuing remediation measures may have a serious impact on the socio-economic structure of the communities concerned. Such impact may ensue from restrictions on land-use or marketing its products, or from perception by the outside world, which e.g. shies away from buying the products. Compensations paid to the affected people can be a major item of the overall project costs. While some side-effects of the project may desirable or even intended, such as creating employment, at the same time, some kind of dependency on the project ('cargo culture') may develop.

Local land-use and landcover in the region will also affect the remediation decision. Hence, decisions on the remediation of a contaminated urban site may be very different from those taken in a wilderness area. In the first case, the local needs for industrial or commercial lands may shape the final end state and require a different remediation process.

While it is understood that the socio-economic context would be very much site and country specific, it may be helpful for regulators and operators alike to develop a clear understanding of the various factors and their possible interactions.

Culture and Communication

The culture of communication varies considerably from society to society and the notions of desirable methods of communication upheld by Western communication scientists and sociologist are not easily applicable in a different cultural context and all Member States. Efficient communication between decision makers and stakeholders-whether be it one-way or a dialogue-has proven to be difficult enough in a homogeneous cultural context. How much more difficult is communication across cultural boundaries, as is frequently necessary in Member States comprising various ethnic groups, an international corporation context, or were foreign experts are involved. Contrary to Western views, but also gaining ground there within certain groups of the public, Eastern and Native American ways of thinking often reject materialism and the importance of economic values, view nature as cyclical, life as a struggle for balance within nature, and value science less than does Western culture. This has obvious implications for risk perception and communication. Cultures that are less individualistic, are likely to take issue with decision making strategies based on scientific rationale, which actually may appear irrational in cultures, where nature is seen as most powerful. Claims that the risk of some project are minimal, or that contamination can be effectively contained or cleaned up, may be seen as full of hubris [5]. A view that is increasingly shared by many in the Western world, following a change in paradigms with respect to valuing scientific rationale in the last few decades.

WHO BENEFITS ?-THE PUBLIC AND THE STAKEHOLDERS

The concepts of 'public participation' and 'stakeholder involvement' have mainly emerged in Western Europe and North America, where in some countries direct participation of citizens in decision making processes has a long history. Nevertheless, the following deliberations concerning affected groups are equally valid in a different cultural context, even though 'active' participation has no tradition there and may not be sought (yet).

The definition and delineation of the 'public' and the 'stakeholder' is neither straightforward nor unequivocally accepted. Indeed, any one individual can be both, member of the public and stakeholder, depending on whether the private, political, or professional aspects of the life are concerned. Typically, the 'public' comprises 'stakeholders' such as affected citizens and civic organisations, environmental groups, labour organizations, schools and universities, representatives of business interests (e.g. chambers of commerce), representatives of government (local, regional, state etc.), and the scientific and technical expert community (academia, professionals' organisations, government departments). However, not each member of these groups or not all groups are necessarily directly affected by the contamination in question and the related remedial activities. The question of whether all 'concerned' or only those 'affected' should be considered stakeholders in the decision making process remains unresolved to date-not the least because a clear definition of the groups is difficult.

Stakeholders are likely those individuals or organizations which have an interest in the results of a resmediation project or are affected by that project. Although identification of stakeholders is difficult, consideration of the following questions may provide some guidance as to their identity:

— Who has the information and expertise that might be helpful?

— Who has been involved or wanted to be involved in similar risk situations before?

— Who may be affected, with or without their knowledge, by the remediation planning?

— Who may be mobilized to act or angered if they are not included?

The emergence of NGOs (Non-governmental Organisations)-despite their qualitatively mixed appearance-has had a positive effect in many Member States. Acting as a voice for less influential societal groups, they have been playing a mediating role between the communities, on the one hand, and the government on the other, allowing to frame the concerns. However, it may be stated that most of the NGOs have their own perceptions and agenda, which may often be at variance from those actually affected, sometimes because of different socio-cultural background of their key leaders and workers. In the process, NGOs may not only impose their own perspectives, but tend to expand their own space and establish their indispensability as mediators [6].

The following diagram (Figure 1) indicates potential actors, or affected parties, within a remediation programme. It should be noted that the diagram is for information only, and is far from comprehensive. In the different societal systems of the different Member States actors may appear under different names and guises, may be one and the same person or organisation, and are not necessarily active. Table I summarises the interests and potential benefits for the stakeholders in an environmental remediation project.

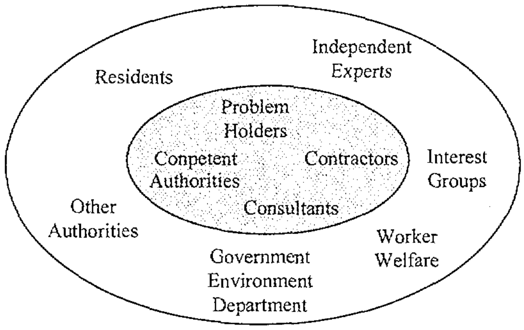

FIG. 1. Stakeholders, after [7].

Various groups of the public will be affected by both, the contamination and the remediation process, in various ways. There will be also a considerable difference between actual effects and risks ensuing and those perceived. Individual or group decision makers dealing with radioactive contamination issues, naturally base their decisions on the problem as they perceive it. It is important to recognise that 'perceived' risks are as tangible as 'real' risks as far as the decision making process is concerned. In planning for remediation objectives, including future land use, and before taking any step towards remediation, it is important to take the community's perceptions into consideration. Local attitudes, perceptions and values have formed over long years, they are active agents in organizing a system of resources use in practice, and they reflect the basis from which a future land use and other benefits could emerge.

The result are sometimes considerable differences in reasoning/logic between the 'public' and decision makers and between official/scientific estimates of benefits and risks ensuing and those perceived by the communities, leading to misunderstandings on the goals and objectives of a project. Priorities might also change with time and as remediation progresses. Those immediately affected might be concerned at the beginning with health risks, but later on in the process, economic criteria typically become more dominant. These problems have been, for instance, addressed by a recent OECD-workshop [9], but no simple solution to the problem is available. The objective should be to reach, by conflict management, a 'win-win' situation.

Providing for public participation is likely to require a non-negligible amount of financial resources, which is an important reason-apart from differing traditions in governance-why it seems to frequently implemented in more affluent countries. Means for measuring success and positive contribution of participation, therefore, are justified requirements in a project management context. Measuring success is complicated frequently by the fact that public participation does not necessarily lead to tangible results and a 'control case' without participation for comparison does not exist. Rather, participation typically results in a reduction of programmatic risks and in savings, i.e. in averted overruns of schedule and budget. The public concerned may apply different measures of success, according to their agenda.

TABLE I. THE FUNCTION OF INTERESTED PARTIES, AFTER [8]

ACTORS	INTERESTS AND EXPECTED BENEFITS
Problem holder	cost effectiveness functionality of soil efficient decision-making
Authorities	multifunctionality of soil minimisation of remaining environmental load consistent policy efficient decision-making maintain/improve tax revenue through viable economy
Consultants	looking after the interests of the client (problem holder or competent authority) efficient decision-making
Contractor	looking after the interests of the client efficient decision-making
Public	risk reduction minimal limitations of use minimal nuisance efficient decision-making maintain/improve socio-economic situation

BALANCING BENEFITS AND RISKS

A number of specific factors and constraints can be identified that will impact more or less directly the decision making process on a remediation programme. Many of them have to be included explicitly and actively into the balancing process in order to make the latter most efficient. They include inter alia:

— socio-economic factors, e.g. employment, infrastructure;

— costs, funding, and availability of resources;

— regulatory aspects, such as clean-up standards and competing legislation;

— public perception/acceptance and public participation;

— governance issues;

— assessing the risks affecting remediation technologies;

— occupational hazards;

— environmental impact;

— remediation objectives, e.g. envisaged land-use.

In the following, those factors from the above list will be discussed in more detail that have the largest potential for generating added value and optimisation of overall benefit from an environmental remediation project, or that entail significant implementation risks.

Socio-economic background

Depending on the size of the problem, remediation decisions can have wide-ranging economic implications. Those implications may occur over short time-scales or long time-scales. Rationalising the impact of economic considerations on the decision making process is not a straightforward task [10]. Constraining decisions are often taken on political grounds and are not necessarily related to scientific or technical aspects of the environmental remediation problem. Therefore, the economic benefits, or detriments for that matter, of decisions on remediation projects should be evaluated *a priori*.

Economic impacts of contamination events may manifest themselves in a variety of direct and indirect forms, including loss of property value, loss of markets for agricultural produce, job losses, relocation costs, costs of extended commuting to farther workplaces, or higher cost of food-stuffs. Unlike the siting of nuclear installations, including waste management facilities, where often the negative perception of things nuclear prevails [11], owing to the inherent benefits, there should be an inherent positive perception of the remediation activities. The remediation measures may bring with them an influx of money. The average education of the residents often increases as a result of improved access to it owing to the financial means available. Overall, the standard of living increases-at least with respect to a situation without remediation-and sometimes above pre-contamination levels.

Social groups typically differ in their perception. For example, certain groups of the public may be reluctant to support a given proposal affecting their settlements owing to an inability to move elsewhere-often reflecting a lack of inward investment, or regional decline, thus lowering its respective appeal. This is not to say that the individuals actually wish to leave-just that if they should wish to do so, they are unlikely to find a buyer for their property, or receive a relatively low price which curtails their ability to purchase elsewhere. There is, therefore, a perception of inhibited mobility, which may not be felt by other groups, who retain more flexibility/mobility. Typical examples include the rural communities in developing countries, but urban middle and upper classes in developed countries living in declining regions have found themselves in a similar situation.

The choice of remediation technologies should be tailored to the socio-economic needs of a region and the respective resources available. Thus the overall economic benefit for a region might be improved by choosing a perhaps less sophisticated technique, but involving more local human and other resources. Or, drawing out a project over a longer time scale, thus keeping local staff employed for a longer period of time, might be more economical at the bottom line than earlier completion followed by paying unemployment benefits; and it may add a social dividend. Working out such trade-offs requires the collaboration of all parties involved, the contractor, the operator, licensing authorities and the funding bodies. Installation of a quantitative decision making system allows to make the complex process of decision finding transparent to all stakeholders and parties.

Employment

Employment rates effectively provide a measure of the direct and indirect jobs created through remediation process implementation. Employment is an important socio-economic factor to consider within any decision making process. Often for past practices employment has been in decline owing to (large-scale) facilities being closed down (e.g. the nuclear complexes in the USA and the former Soviet Union). Employment can be effected in a number of ways, namely;

— directly during the physical implementation process and any required aftercare by creating jobs on these projects;

— indirectly in other economic areas within the local community, for example due to increase in business volume of shops, hotels and other service industries;

— owing to the general socio-economic revitalisation of areas previously in decline.

Skill base and education

Depending on the size and nature of the problem, the design of remediation programme may both, be determined by the skill base and level of education available in the community or region, and be impacting on these. Local unavailability of skilled personnel may well preclude implementation of an otherwise viable remediation option. The problem can be overcome by either drafting in staff with the required skills, or by training and education, if project resources and time scales permit this. Re-training and re-deployment of scientists and engineers from the workforce of the previous operation on a site is a major element of the conversion programmes from nuclear weapons production to civilian activities in the USA and the successor countries of the former USSR.

The effects on the socio-economic situation of the communities may be quite varied, again depending on the scale of these measures with the respect to the size of the community. A sizeable influx of outside workers with higher levels of education and/or higher levels of disposable income may give rise to social tensions, but at the same time boost the economic situation of the community. Training and education of locals is likely to improve their 'market value', but can later on induce demographic changes, e.g. by outward migration following the completion of the remediation project. Assessing such effects in detail is probably beyond the means of the average remediation project, but decision makers on the (higher) political level may well be guided by such deliberations.

Infrastructure

The quality and availability of local infrastructure can affect, and in turn may be affected by a remediation programme. Relevant variables include:

- — the physical setting of the site;
- — local facilities, e.g. transport (road, rail networks), accomodation, etc.;
- — regional facilities, e.g. transport (road, rail networks), waste disposal facilities;
- — general state of development.

The added value from improvement of infrastructure may be an important factor in the decision making process. Due to the numerous disparate factors which describe an area or community infrastructure, it is not possible to be prescriptive with respect to methods to be used for the analysis of potential benefits for and impacts on the infrastructure.

Regulatory, and institutional aspects

Side effects of planned remediation measures may run a-foul with legislation in related fields. For instance, changes in land-use may have impacts on drainage pattern, on groundwater recharge quality, may lead to eutrophication of surface water bodies, on the ecology of protected landscapes, and so on. A predictive assessment may be needed to ascertain that no such impacts will occur [12].

Environmental risks and benefits of remediation projects

The implementation of a remediation project may result in a variety of environmental impacts in addition to those resulting from the contamination itself. Possible impacts may concern natural resources such as surface waters, groundwater, air, geological or biological resources. Impacts on biological receptors can be assessed in terms of mortality or diversity. Natural resource damages can be assessed in terms of mitigation of existing damage or prevention of new damage.

Adverse impacts to ecological receptors that are located on-site or off-site may occur due to the deployment of a given remediation technology. Deployment of plant and any other works can cause significant disturbance to the site ecosystem and its surroundings. For instance, certain technologies, such as removal of topsoil or soil washing effect the removal of surface contamination, albeit at the cost of destroying the soil ecosystem. Thus, the value of an ecosystem might need to be balanced against the likelihood and magnitude of radiological impacts.

An area larger than the actual contaminated site may be required for installations, intermediate storage of wastes and so on. Removal, transport and disposal of residual wastes may result in environmental impacts and risks at locations other than that of the original contamination. There is, for example, little benefit in removing a contaminant that is well fixed on a low volume of soil, only to produce a high volume of an aqueous waste with the contaminant in a more soluble or mobile form. In addition the remediation techniques chosen should not generate large quantities of secondary waste and should not pose risks of exposure to the public or operators that exceed the risks of quiescent contamination [13].

On the other hand, remediation projects may be designed to deliberately increase environmental benefits, for instance by improving biological diversity through creating certain types of habitats.

The decision making process must include such externalities of detrimental and beneficial nature. The potential for environmental risk may be an important factor in decision making because some remediation technologies are more likely than others to produce adverse impacts on ecological receptors, including habitat disruption, or generate natural resource damage [14].

The basis for assessing environmental risks and benefits can be obtained from a wide range ecological field and modelling studies, the use of contingent valuation, and other techniques to measure use value, existence value, intrinsic value and the ensuing costs of environmental damage [15]. Consideration should be given to the use and application of established environmental impact assessment (EIA) methods.

Co-contamination issues

Co-contamination issues offer a good example of where a sound understanding and balancing of technical and non-technical factors is required. In many practice related contamination situations remediation is complicated by the co-occurrence of contaminants of radiological and toxicological or eco-toxicological relevance. This is frequently the case for mining and milling operations, were heavy metals including arsenic are accessories to the ore, or actually may be the major constituent. In other cases hazardous and low-level radioactive wastes may have been co-disposed (mixed wastes) [16] in a situation now requiring remediation. Complex practices, as for instance were/are found at large research centres, have led to multiple contamination's.

Different clean-up efforts can lead to conflicting clean-up goals at a particular site or to an unusual partitioning of a site into different clean-up units. The foreseen remediation technology has to take into account the possibly different geochemical behaviour of the contaminants. In other cases, the radiologically relevant component may be of lesser importance than the chemo-toxicological ones, and remediation criteria and technologies may need to be tailored according to the latter.

The different types of contaminants may also give rise to different types of waste streams and related conditioning and disposal requirements. Disposal facilities for hazardous wastes typically are not licensed to accept radioactive wastes and vice versa. The necessary separation of wastes will add to the operational costs and the cost of treatment and disposal.

Future land use-Objectives and restrictions

One of the overarching objectives is that the remediation should not only improve the radiological situation, but that it also should not result in undue detriments to other properties of the site. The base-line case for future land use in accident scenarios would be return to its previous use, while for past practices it would be the unrestricted release [1]. In practice, the possible land use depends on the degree of restrictions placed on it due to any residual contamination remaining. Restricted use (industrial or commercial) or unrestricted use (residential or agricultural) as remediation end-points influence the kind of technology to be implemented and level to which remediation has to take place [13].

The degree of restrictions to be applied may vary between different areas forming part of a larger contaminated site. Certain parts of a 'site', i.e. the location of an industrial or other operation, may not have received any contamination at all, and therefore could be turned to other uses without restriction. Chosen end-points for remediation and hence the amount and form of residual contamination can put restrictions on certain forms of land use.

Information on pre-existing plans can be obtained from land management plans, land use decisions, zoning regulations, building regulations, or any other relevant spatial planning instruments that are available. If the future land use is unknown or undecided, as a basis for comparison, a common assumption can be made for all remediation options. Land use, however, can also be a variable in itself during the decision making process, allowing for optimisation within certain limits set e.g. by the criteria justifying remediation [1].

Land use after environmental remediation in many Member States is a public participation and community issue. The issue often is part of a broader transition in the local economy. The contaminated site may have been part of the operation of a major local employer, who now has ceased to exist, or has changed the market sector, with ensuing changes in employment levels and structures.

In the interest of the public, a "most beneficial use" of surplus land in government ownership should be found, which reflects a balance among various goals, including maximum return to the taxpayer, wise land stewardship, adherence to community values, economic development, environmental protection, cultural and natural resource preservation, and aesthetic value [17]. For some sites, the most beneficial use will be readily evident. For example, if a site is already industrial and can be re-used to create jobs as an industrial area, the re-use determination is likely to be relatively simple. For other sites, where multiple uses are feasible and natural and/or cultural resources are present, determining the most beneficial use may be more difficult. The most beneficial use will depend upon the site's particular traits, strengths, and weaknesses, as well as the goals that the site, affected governments and communities, and other interested parties would like to fulfil through re-use. Community support is particularly critical in cases where institutional controls are needed to ensure a specific, limited use. A site may have multiple re-use alternatives with each option satisfying one or more particular values.

SUMMARY AND CONCLUSIONS

The local factors-social, cultural, and economic goals and values-will form a critical backdrop to the process of defining the remediation objective and the way towards it and are more or less independent of the traditions of governance in a given country. The choice of remediation technologies will need to be tailored to the socio-economic needs of a region and the respective resources available. A notions that is even more important in countries with economies under pressure at present. Thus, the overall socio-economic benefit in a region might be improved by choosing a perhaps less sophisticated technique, but involving the local man-power and other resources. Or, drawing out a project over a longer time scale, thus keeping local staff employed for a longer period of time, might be more beneficial at the bottom line than earlier completion followed by paying unemployment benefits; and it may add a social dividend.

The intended use of a site following remediation is likely to be a factor significant for the overall benefit from the remedial operation.

Working out such trade-offs requires the collaboration of all parties involved, the owner of the contamination, licensing authorities, the funding bodies, the contractor, the operator, and indeed the affected people themselves.

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DISCUSSION AFTER THE PRESENTATION OF W.E. FALCK

V. NOVIKOV (International Institute of Applied Systems Analysis): In your presentation you spoke of "environmental sustainability" and "socio-economic sustainability". Could you say briefly what you mean by those terms in the context of environmental restoration?

W.E. FALCK (IAEA): When speaking of "environmental sustainability", I have in mind-in line with Agenda 21 of the Rio Conference-the use of the environment in such a way that future generations are not prevented from using the environment in a similar way.

When speaking of "socio-economic sustainability", I have in mind the conduct of an environmental restoration project in such a way that, after any boost to the local economy resulting from implementation of the project, the community in question is able to continue living essentially as it lived before.