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Article

Opportunity and Problem in Context (OPiC): A Framework for Environmental Management

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Abstract: Most frameworks used in the management of environmental problems focus on problem analysis and pay little or no attention to the explanation of the problem and the opportunities for solving it. The Opportunity and Problem in Context (OPiC) framework aims to be fully balanced in this respect. On a broad theoretical footing, the framework can give structure and interconnection to (i) the analysis and explanation of environmental problems by making use of parallel effect chains and norm chains, the functions and values of the environment, a breakdown of human action through lifecycle principles and explanation through fields of causally related actors, (ii) the identification of opportunities for solutions based on the problem analysis, on system concepts and on creativity enhancement, and (iii) the synthesis of this in the process of design and evaluation of solutions. The OPiC framework has been developed with a special view to developing countries but its applicability is not greatly dependent on scale and context.

Keywords: OPiC, environmental management, framework, DPSIR, environmental problem analysis, environmental problem explanation, actors, policy design, equity.

1. Introduction

Environmental management makes use of frameworks that serve as broad methodological guides to organise explorations, research, modelling and reporting. Examples of such frameworks are environmental impact assessment, cost-benefit analysis, lifecycle analysis and the Drivers-Pressure-

State-Impacts-Response (DPSIR) [1]. Characteristically, all these frameworks are geared towards (partial) problem analysis, with no attention to problem explanation and the positive opportunities that exist in the context of the problem. In addition, the frameworks are difficult to operationalise, especially in terms of identifying opportunities that will prevent and solve pollution problems. With society endowed with great deal of opportunities such as local development initiatives, local knowledge and traditional values, ecologically sound production techniques, etc., there is the need to exploit and harness these opportunities as a way of finding solutions to pollution problems. The present paper presents a framework for environmental management that overarches all others and adds elements of its own. It has been developed with special attention to pollution management in developing countries, but has a broad range of applicability that includes the industrial societies and land use related problems. The framework is called Opportunity and Problem in Context (OPiC).

The framework is based on two hypotheses: (*i*) in almost any context, problems intermingle with opportunities that may enhance the efficacy of environmental policies and (*ii*) environmental management frameworks express underlying paradigms that go into fundamental issues in order to arrive at a more comprehensive structure that is truly multi-disciplinary and grounded in balanced foundations.

The paper starts out with the presentation of the principles underlying the OPiC framework (Section 2) and then moves to a description of the framework itself (Sections 3 and 4). A brief enumeration of issues of applicability follows in Section 5. More details on all aspects of the present paper can be found in the first author's Ph.D. thesis [2].

2. Principles of the OPiC Framework

The OPiC framework has conceptual building blocks, which are related to principles of interdisciplinarity, models of causal chains and systems, and concepts of governance and sustainable development.

Principles of mono, multi, inter and transdisciplinarity

The response of the scientific community to environmental challenges started within the various disciplinary domains. Disciplinary science based on reductionist views remains the best source for gaining in-depth knowledge about single elements of the broad framework, such as pollutant dispersal, economic cost and benefits or environmental regulations. Environmental issues also require some degree of grip on the whole, however, and the next step in the development of the environmental sciences were various multi-disciplinary approaches, whose characteristic products were overview schedules such as DPSIR and the functions of the environment [3]. Complex environmental problems and the design of synthetic solutions require more than that, however [4], stimulating the move towards interdisciplinary approaches in which the scientific fields become truly connected [5]. The PiC framework of De Groot, a precursor of the OPiC framework, is a typical product of the interdisciplinary drive [6]. Next in line have been the transdiciplinary models in which environmental science (or 'sustainability science') began to develop into a discipline of its own, with new (people-environment) system models [7]. Material Flows Analysis is a characteristic example, representing as it does a framework for modelling material flows in economies and the environment [8].

The OPiC framework incorporates several products of the multi-, inter- and transdisciplinary traditions and puts them into a coherent epistemological whole. A monodisciplinary product such as cost-benefits analysis combines well, for instance, with functions of the environment, placed at the causally ‘downstream’ side (social causes) of environmental problems, and the interdisciplinary approach of Life Cycle Analysis is used to elaborate environmentally relevant human action at the ‘upstream’ side of environmental problems. Moreover, the multi-disciplinary repertoire of techniques of Participatory Rural Appraisal [9] is found to be a support in the elicitation of the local perceptions of problems and opportunities alike.

Causal chain principles

Most environmental management frameworks have a basis in causal reasoning [10]. They depict how human activities result in emissions of substances, how this results in ambient concentrations, how these result in impacts on target organisms and so on, coupled with ideas on how societal goals result in environmental standards, and these in turn in land use prescriptions, and so on. For its greater part, OPiC uses and expands on this tradition. The practical reason is that causal insights translate easily into options for interventions; once you know the causal mechanisms that build up a problem and the factors causally underlying a problem, the first step towards the solution(s) has been taken. The scientific reason for a focus on causal chains rather than systems is that the concept does not run into the often futile discussions about system boundaries and system coherence. Causal chains need no boundaries or coherence to exist. In fact, causal chains never end. Downstream along the causal current, every impact will cause a new impact. And upstream along the current, every cause will have a next cause behind it. That is why in schemes such as OPiC, it is in fact fundamentally conventional where along the causal chains “the problem” is defined to begin and end and what is defined as “the causes” of the problem. OPiC follows the conventions, by defining human activities that directly impact the environment as the beginning of an environmental problem, and the impacts on politically relevant variables (human health, biodiversity etc.) as the relevant ‘final variables’. The causal focus implies that OPiC is weak in spatial terms. GIS systems and maps may easily be added to it, but are not contained in the framework itself. In policy making terms, OPiC is a great support for finding out *what* to do, but not for *where* to do it.

The causal focus enables OPiC to connect environmental problems and opportunities firmly to their contexts. Roughly, these contexts are the (social, ecological and normative) worlds there the problems and opportunities causally originate. An important principle of discovery here is ‘progressive contextualisation’ a term coined by Vayda [11] to denote the stepwise search for causes and the causes behind these, starting out from relevant elements in the environmental problem. (For instance, the actors and factors behind human activities and the actors and factors behind these.) OPiC mixes this actor-based, ‘multi-micro’ approach with a ‘macro’ system exploration.

System principles

It is often said that real leverage in the management of complex situations lies in understanding dynamic system-level complexity, not detail complexity [12-14]. System-level complexity refers to the way situations are inter-linked (components are physically joint together), inter-related (action of one component affecting other components) and inter-dependent (health of the entire system and the proper functioning of each component). Although not in the heart of OPiC, the framework does pay heed to this call for system-level methods and concepts. Systems may be taken up as parts of causal chains, e.g. when a shallow lake ecosystem is part of a pollution impacts chain. Secondly, systems thinking may accompany causal chain thinking, as in the macro-analysis accompanying the chained micro analysis in the progressive contextualisation (explanation) of human actions. Most fundamentally, however, system concepts find their place as alternative ‘generators’ of options for solutions. One set of concepts comes from the emerging discipline of industrial ecology, focusing on creative technical solutions and the closing of loops in materials flows. Material flow analysis is the basis for the reduction of claims on primary and natural resources. This includes the reuse, remanufacturing and recycling of products and a shift towards renewable resources. A second set of ‘system ideas’ for the identification of opportunities comes from non-equilibrium ecology [15] that stresses system resilience and the key role of adaptation in sustainable management [16]. Adaptive management is one of the design principles for the development of solutions in the OPiC framework. Another area in the OPiC framework where adaptive management should be used is environmental assessment and management. This involves the integration of ecological and participatory research approaches and adaptive management in this sense refers to a structured process of "learning by doing".

Governance principles

The debate about governance has emerged from two different schools of thought. The first calls for empowerment of groups and organisations outside government institutions. The other school stresses the need for decentralisation, privatisation and consumer orientation. A common ground of both schools however, is hostility to central governments [17] and the move towards “good governance”. In OPiC, good governance is translated into the following principles:

(1) The most important underlying condition for successful decentralization is serious political commitment. This means that central governments must be willing to give up responsibilities and local governments must be prepared to take over such duties. Not all pollution problems can be managed in a decentralised fashion, however, e.g. depending on the physical scale of the problem. Thus, the devolution of authority in pollution management to the lowest possible level will often imply that the central governments retains rights to instruct lower-level governments.
(2) Devolution creates space for co-management, in which the state, companies and communities negotiate to agree on shared responsibilities for a range of pollution management functions.

OPiC should be close enough to common-sense thinking to act as a platform for such negotiations.

(3) Transparency and open, learning organizations are essential for co-management. Since organisations do not tend to be open, transparent and learning-bound by themselves, community voices must be strong enough for co-management to work, even if communities do not have a great deal of local knowledge or local technologies pertaining to the environmental problems at hand. (And often, they have much more relevant knowledge and technologies to contribute than expected by the experts [18].)

Sustainable development principles

A classic theme in sustainable development debate is whether human and natural resources stocks are substitutable and therefore in need of only ’weak sustainability’ [19,20]. OPiC does not make a choice on this and many other issues in the sustainability discourse except for one quite general principle that has been called the ‘foundation of a liberal society’ by Pareto. This original Pareto principle is that a policy can be accepted if it makes nobody worse off (actually and not potentially, as the principle was perverted later in economics) [3]. The ideologies of ‘safe minimum standards’ and ‘basic needs’ are more recent formulations of this principle and in fact, sustainable development can be seen as its most recent and broadest resurrection. Sustainable development wants development to take place on a foundation, a ‘bottom line’ of protection of future generations [21] or, in recent views, on a triple bottom line of protection of future generations, nature and the poor. For the evaluation of policy designs, this gives rise to a ‘two-tiered value theory’, in which proposals must first pass an equity filter (the three protection criteria) before handed over to the efficiency evaluation of cost-benefit analysis. OPiC has incorporated this principle.

3. The OPiC Framework

This section provides an overview of the OPiC framework, organized under three main headings: (1) problem analysis and explanation, (2) opportunity analysis or option identification and (3) the design, evaluation, implementation and monitoring of an environmental management strategy. Figure 1 gives the visual representation.

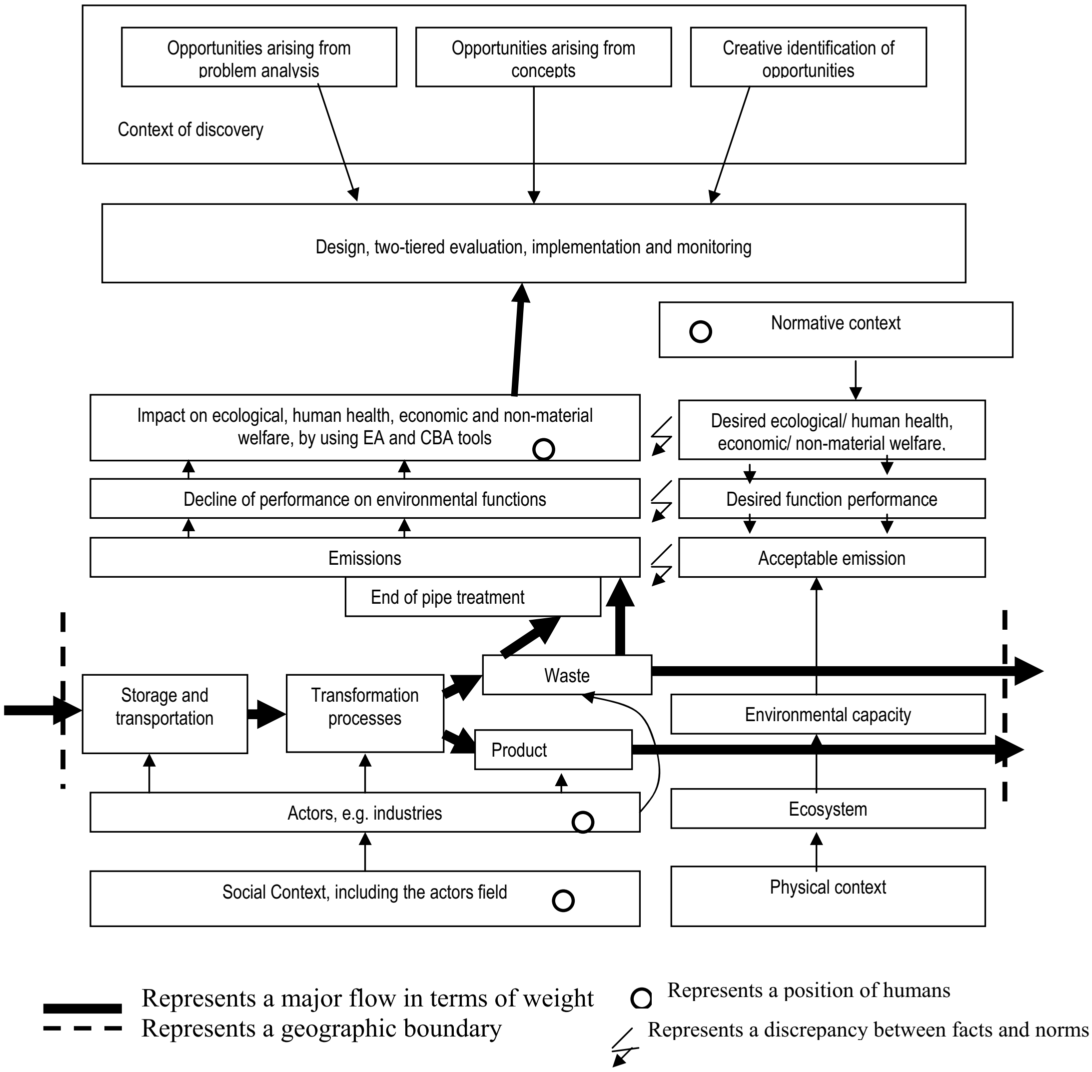
3.1. Problem Analysis and Explanation

In Figure 1, the lower half depicts the structure of the environmental problem in its causal contexts. The process of empirical and normative specification of this structure for the problem at hand constitutes the problem analysis and explanation. The centre of the Figure is formed by the environmental problem itself. It is characterized by the chains of fact/value discrepancies depicted by the ‘flash’ arrows. This structure expresses that any problem is a discrepancy between what the world is and what the world should be (the Is and the Ought, as the philosophers say).

One part of the environmental problem (at the left in the Figure) is empirical, composed of actual or predicted facts. These facts form the effect chains that start out from human activities (often:

emissions), which result in changes in the environment and end with the impacts on the 'final variables' such as human health, development and biodiversity. Describing the effect chain is usually called impact analysis. Environmental dose-effect relationships, environmental models, EIA and broad MCA tools in general [22] may be applied in the impact analysis.

Figure 1. An overview of the Opportunity and Problem in Context framework. In the centre, the environmental problem is characterized by the discrepancies (flash arrows) between environmental facts (real and predicted) and environmental values (norms, standards). The human activities that cause the problem are elaborated following a cradle-to-grave (LCA) scheme, from manufacturing to waste. Problem explanation implies going step by step into the normative, ecological and social contexts of the problem. In the social context primary actors are influenced by an 'actors field' that may comprise many other actors causing the environmental problem. Opportunities (options for solutions) are generated by the problem analysis and explanation but also by system concepts and creative search. The design of solutions is the selection and combination of opportunities to form the higher system level of the (management or policy) plan. Humans are present in four positions; from top to bottom, as standard-setters, as recipients (victims), as primary actors and as indirect (secondary etc, actors) causing the problem.



The other side of the environmental problem (at the right in the Figure) is normative. It is composed of the chains of norm that express the acceptable or desired levels of the facts on the other side, speaking in the same terms. Hence: human health standards, desired levels of economic growth, desired biodiversity, and from there on down to desired levels of environmental state such as acceptable ambient concentrations, and from there on further down to desired human activities. The latter are often called environmental capacity, and describing the whole chain of values (standards, norms) can be called norms derivation. Policy objectives, legal standards and regulations may be used to specify key elements of the norms chains, but others may require the application of scientific models to derive lower-level norms from higher-level ones. These models are basically the same as in the impact study, but applied in reversed causality (e.g. not from predicted emission to predicted ambient concentration but from desired ambient concentration to desired emission). The analysis of the structure and severity of the problem should consider the political and ethical legitimacy of the standard setter and the standard setting process as it does the scientific grounding of the pollution problem facts.

Getting a full grip on the environmental problem amounts to describing this whole ‘problem block’ to a degree of accuracy, certainty and balance that fits the needs of the stakeholders and general professional ethics. The routes through which this is achieved may be highly iterative, however, depending on the case at hand. Environmental functions may well be used as an organizing concept for complex cases, and economic concepts such as Total Environmental Value (TEV; [22]) may be used to (partially) quantify the fact/value discrepancies in final variable terms. Problem analysis may be carried out in a participatory manner, tapping local knowledge but also incorporating local value perspectives. It no agreements or compromises on facts or values may be reached between participants, more than one partially different problem analysis may have to be accepted.

Activity analysis

The human activities causing the environmental problem are identified in the preceding problem analysis. They are sometimes simple enough to not require further analysis. Often, however, it serves to take a more detailed look at the structure of these activities. One approach is to try and decompose the activity in a multiplicative structure of, for instance, number of actors multiplied by activity per actor (the I=PAT structure, *cf.* De Groot [6]). Especially in pollution cases, analyzing material flows in a way that follows the lines of Life Cycle Analysis (LCA; [23]) will often help much to later identify effective points of leverage for solutions. LCA also offers tools and general data to connect emissions to these material flows. The fat horizontal arrows in Figure 1 indicate the material flows, that characteristically run form the ‘cradle’ to the ‘grave’ of industrial products. As Figure 1 indicates, the LCA-based activity analysis may be confined to a specified region, e.g. because the commissioning agency has a responsibility only for that one region. This then implies that processes such as raw material mining or waste emissions, if taking place outside the region’s boundary, are left out of the analysis. The emissions generated by activities taking place within the region may be accounted for without considering these boundaries, however, e.g. when the health of people outside the region is threatened by pollution generated within the region.

The normative context

As said, progressive contextualization is the key method for the explanation of the environmental problem. This process runs from the environmental problem outwards in three directions, starting out from three points in the problem analysis. The normative context stretches outward from the final variables norms. It is entered when critically reflective questions are asked concerning aspects of the final variables that are usually taken for granted (which is why they are 'final'). Examples are questions regarding the need or the distribution of economic growth, or on the way that biodiversity objectives are grounded philosophically, or on the traditionalist biases of frameworks such as OPiC (*cf.* [1]). Questions such as these, overly academic and irritating as they might feel at first encounter, may help much to better adapt, ground and explain environmental science and policies.

The ecological context

One result of the problem analysis is the assessment, however roughly, of the environmental capacity, which is the maximum intensity of the human activity the environment can handle without too adverse effects on the final variables (or reversely, the minimum intensity of a human activity that supports the environment). Going into the ecological context is to search, often in step by step manner, for the factors and underlying structures and processes that determine why the environment has that specific capacity and the degree to which self-renewal may take place after disturbance. This would help, for instance, to determine the potential of the ecosystem to regenerate.

The social context

Knowledge of the social context of the environmental problem is often of great practical importance, because it helps define policy target groups and many options for policy interventions. The analysis of social context starts out from the human actions that directly affect the environment. Examples are manufacturing activities that pollute the environment, or the extraction of natural resources, or dredging of polluted sediments. These actions are identified in the problem analysis and are called primary (or proximate) actions; they are caused (*i.e.* decided upon) by the primary (or proximate) actors.

The core assumption of the further discovery of the social context of the environmental problem is that actors make their decisions on the basis of what they *can* do (called their implementable options) and the reasons that apply to why they *want to* do these actions (called their motivations), *cf.* [24]. Characteristic motivations are, for instance, costs and benefits, long-term risk, reputation, peer pressure, community solidarity or the desire to be a green firm. Options an motivations of the primary actors are in their turn influenced by actions of other actors. For instance, a new prohibition reduces the range of options available to primary actors, a new credit regulation may enlarge the range of implementable options and a levy reduces the motivations of primary actors for the levied action. These prohibitions, levies and all other actions that influence options and motivations of primary actors are called secondary actions. They are carried out by secondary actors, that may for instance be government agencies, large companies, lobby groups, politicians, banks an so on. These in turn have their own options and motivations for their actions, arising from their own 'life worlds' and these in their turn are influenced by other (tertiary) actions and actors. The causal structures thus defined are called the *actors field*. As De Groot notes [3], an actors field is a structure of social causation, different from the 'social network' concept that is usually invoked in the social sciences for describing actor connections. Each actor identified in the actors field may be selected as subject of a deeper analysis of how the actor in fact makes his decisions (e.g. following rational choice theory or some other, more contextual pattern of reasoning) and how the actor's options and motivations are embedded in structural and cultural features of society. This 'deeper analysis' as De Groot calls it [3], proceeds by first decomposing the actor's implementable options into potential options and the actors 'autonomy' (consisting of positive capacity or capitals and bounded by external restrictions such as taboos), and decomposing the actor's motivations into 'objectified motivations' (expressed in terms of money, time etc.) and the (cultural, psychological) interpretations of these objectified motivations. It may then be analysed how these elements are embedded in the actor's culture, the micro-structures the actor is member of and the macro-structures of the actor's society (markets, tax structure etc.). The analysis can be done as a desk study but also involve interviews and participatory methods.

3.2 Opportunity Discovery and Realisation

Opportunities are here defined as all actions that may become part of the solution or prevention of a problem.

Opportunities arising from the problem analysis and explanation

Essentially, all causal connections identified in the problem analysis and explanation offer a potential point of leverage for problem alleviation or prevention. From the problem analysis arise the technical opportunities such as diversion of polluted flows, improving of environmental capacity to handle pollution, end-of-pipe technologies and so on. The activity analysis generates insight into the life-cycle phases that may best be targeted and the manufacturing processes that might be improved for most efficient impacts. From the normative problem explanation (contextualisation) arise options to re-state standards in a justifiable manner. The ecological context sometimes holds options to strengthen the ecosystem's carrying capacity. The social contextualization, finally, generates the potential target groups and the potential social, economic and cultural policy instruments for problem solutions. One key rule here is that all actors in the actors field are potential addresses ('target groups') for policies. The second rule is that for each potential target group, the potential content of interventions are indicated through the 'deeper analysis'. These 'policy instruments' may be classified as:

(1) Opportunities addressing the actors' potential options, e.g. knowledge provision and extension
(2) Opportunities addressing the actors' autonomy, e.g. strengthening the actors' capacity to implement positive actions they might be motivated for (e.g. through credit schemes) and reduce the capacity of negative actions (e.g. through prohibitions)
(3) Opportunities addressing the actors' objectified motivations, e.g. levies, subsidies, deposit-refund schemes, changes in institutional contexts, extended producer responsibility (EPR)
(4) Opportunities addressing the actors' interpretations, e.g. environmental communication, enhancing the prestige connected to non-pollution, etc.

Identification of these options may be carried out by the analyst alone, but also through joint enquiry with stakeholders, NGOs and the wider public.

Opportunities arising from industrial concepts

Apart from the problem analysis and explanation, concepts developed in industrial ecology and allied disciplines may serve as a source to identify opportunities for problem prevention and abatement. 'Cleaner production' is a tradition focusing on waste reduction through the analysis of industrial processes and the reasons (in methods, people, machines and materials) why these are run the way they are. Options arising from this type of analysis characteristically concern waste-reducing process improvements, change in the behaviour of consumers and producers. A more recent school of thought in industrial ecology uses tools such as Material Flows Analysis [8] to draw up an integrated view of the interaction between industries and society. Characteristic opportunities arising from this are 'eco-industrial' development that links various industries and communities to reach greater overall material efficiency, and 'dematerialisation' which is to reach the same added value with less material use. Developing countries provide ample options to apply these types of analyses and opportunities. MFA may be applied in a semi-quantitative manner, for instance, to support regional pollution management, and a special version of MFA has been developed for use in rural communities [25].

Opportunities arising from creativity

Traditional ecological knowledge, comprising factual environmental knowledge, knowledge on traditional environmental management systems, social institutions and cosmologies (e.g. [18]), may be tapped to identify alternative options for pollution management, e.g. through participatory local appraisal, focus groups or advisory committees. Creative capacities can also be found internally within pollution management teams. Available methods to enhance this source of options focus, for instance, on the reflective breaking of routines and on brainstorm techniques. Also dreams may be taken as opportunities for creative options identification.

Context of discovery

The fruitfulness of all three sources of identification of options for pollution management depends much on the presence of an enabling context of discovery. Regular environmental data gathering routines, e.g. connected to environmental accounting or ecological accounting, can form an important element in this context. Apart from these formal tools, people form the second pillar under effective options identification. Self-efficacy is the key notion here. It is defined as a person's judgement of his/her own capability to organise and execute courses of action. Self-efficacy has a special relevance for developing countries because people in environmental management often feel inferior to Western experts or are locked up in authoritarian management systems that reward the passive execution of tasks. Self-efficacy can be enhanced by way of persuasion, training, support groups and role modelling. Thirdly, learning (individual and organisational) is the key process in the context that enables effective options identification. For pollution management, learning should be anchored in the actors' own experiences and be organised as a dynamic group process.

3.3 Design of Solutions

Design is the selective combination of options (opportunities) to form the higher system level of a plan, e.g. a pollution management strategy. Physical and social options have been identified as elaborated in the preceding section. The social options are often categorized under the rubrics of market-based, regulatory and communicative policy instruments, and conflict resolution. Market-based instruments comprise charges and taxes, tradable permits, subsidies and performance bonds, eco-labelling and direct payments for environmental services. Regulatory instruments comprise environmental standards, international regulations such as conventions, and voluntary agreements. Communicative instruments comprise environmental reporting and environmental education. Conflict resolution approaches entail elements such as public consultation, negotiation, mediation and arbitration.

Environmental strategies display certain overall styles of operation. They may, for instance, be community-based or technocratic. A conscious choice of basic style is important for the design of any effective plan. For pollution management strategies in developing countries, three aspects of overall style seem especially important. They are co-management, participation and adaptive management. Co-management involves the sharing of visions, power and responsibilities between government and industries. Participation connects stakeholders and the wider public to the planning and implementation process of environmental management. Adaptive management, contrary to blueprint approaches, implies intensive monitoring and rapid responses to change, guided by a long-term vision. Locally crafted combinations of these overall styles would appear to be appropriate for developing countries.

Policy design is a creative process, since the elements (i.e. the options selected to form part of the plan) interact to form overall system characteristics that are not reducible to the separate options themselves [3]. What has been said about the context of discovery therefore also applies here. Moreover, it follows that opportunities should never be approved or rejected separately; only the various plan alternatives as a whole should be evaluated.

4. Evaluation of Designed Solutions

After designing a solution or a set of alternative solutions based on the preceding insights, a two-tier evaluation should be undertaken. The first step is an equity filter. The second step is composed of an efficiency assessment and adaptability test.

Equity filter

Equity is the protection of values that are not or only very poorly included in cost-benefit analysis or other instruments that assess the overall efficiency of the solutions. The filter is composed of the following questions:

(1) Do future generations not become worse off? In other words, is sustainability truly ensured?
(2) Do the poor or other vulnerable groups (women, children) not become worse off? This especially concerns their basic needs such as health, livelihoods and means to participate in society.

(3) Does biodiversity, especially endangered species, not become worse off?

The designed strategy should have positive answers for the above questions (*i.e.* pass the equity test) for it to be entered into the efficiency assessment and adaptability test. If the designed strategy fails the equity filter, it has to be redesigned.

Efficiency assessment

Efficiency is the degree to which the desired outcomes are achieved at a lowest possible cost. If a designed solution has passed the equity filter, the efficiency assessment is freed from obligations that it can only poorly fulfil. The use of a discount rate in cost-benefit analysis, for instance, is not problematic any more because the interests of future generations, which are discounted away in the efficiency assessment, have been secured through the equity filter already. The prime instrument for efficiency assessment is cost-benefit analysis (CBA). CBA proceeds by first selecting the methods by which as much as possible of the final variables (policy aims) can be expressed in monetary terms, then apply these methods and then integrate the resulting data, using a discount rate, to calculate the Net Present Value (NPV) or some other overall efficiency indicator of the designed solution [22]. In most cases in developing countries, contingent valuation methods such as willingness-to-pay (WTP) would appear to be the best standard method for the monetarisation of final variables.

Adaptability test

Designed solutions may be equitable and efficient and yet too inflexible to respond to future change. Adaptive management requires a specific test to address the adaptability aspect of the designed strategy. The following questions appear to be key in this respect:

(1) Is the designed solution free of path-dependent traps and does it leave options open for future adaptations?
(2) Does the strategy comprise an intensive and rapid-returns monitoring schedule and an institutional structure that enables quick responses to monitoring results, especially at the lowest possible institutional scale?
(3) Have the actors within the context developed a culture and structure for collaborative learning for environmental management?

5. Applicability of OPiC

To ensure the successful use of OPiC, certain conditions have to be met. Even then, even a broad framework such as OPiC has limitations. These are the issues of the present section.

(1) OPiC may well be used as a toll in conflict resolution, for instance to give all actors a common footing in systematic analysis and to focus actors on what they really need in stead of their prefixed positions [23]. OPiC does not contain conflict resolution tools, however. This implies that fruitful use of OPiC as a stand-alone instrument requires a basic willingness of actors to work together. If conflict and distrust prevail, OPiC should become overarched by a conflict resolution umbrella.

(2) OPiC may work well even on a weak data and modelling basis, as often the case in developing countries. This then requires, however, that actors trust each other's data and interpretations to a sufficient degree, in order to avoid endless bickering over poorly known facts and values. Small data gathering exercises may well be integrated in an OPiC process but if data gaps are not bridgeable by trust or small explorations, the OPiC process should be re-conceptualized and changed into an (OPiC-led) data search.

(3) Although OPiC is structured in main 'blocks' of problem analysis and explanation, options search and strategy design and implementation, practical planning processes are seldom run an such a 'linear' sequence. Efficient planning may start out with a preliminary exploration, then start up with a demonstration project as a kind of pre-implementation, then move towards a formal analysis of the social causes and the social opportunities, then re-study the problem analysis in a participatory manner and so on, or follow any other cyclical sequence. OPiC may guide all these separate steps but it does not contain rules for the overall process. Practical use of OPiC therefore requires the presence of an agent with enough expertise to facilitate the OPiC process as a whole. This agent can use OPiC as a menu, not as a cookbook [9].

(4) Through the design of solutions, application of OPiC is likely to result in proposals of institutional (legal and/or organisational) change. Such proposals have a future only, however, if they can build on a sufficient basis of core institutions and good governance. In strongly disrupted or corrupted contexts, OPiC applications may amount to good academic exercises but the key problems are likely in need to be solved first.

(5) As said, the focus of OPiC is primarily *causal*. Almost all arrows in the overview picture of Figure 1 are causal arrows. This is a strength because insights in (physical and social) causal chains are essential to design solutions that really work. The causal focus presents a limitation too, however, especially in the spatial sense. OPiC is strong in telling why things happen, but not in where they do. Spatial questions are sometimes trivial or unimportant, e.g. when we already know where our industries are or when we are not interested in the address of a government agency. In other cases, spatial questions are resolved by the models that we may apply within an OPiC application, e.g. a model of pollution diffusion. In other cases however, a geographic component may have to be added to OPiC, e.g. using a geographic information system (GIS).

(6) OPiC is applicable to existing environmental problems, e.g. for pollution or resource exhaustion abatement. Usually, real-world situations comprise both elements of problem abatement and problem prevention. OPiC is able to handle these mixed situations in a single application. This enables actors to find synergy between the two aspects, for example, using the knowledge and opportunities that arrive with the establishment of a new industry in the abatement of pollution by existing industries.

(7) OPiC may be used not only for *action* purposes as it is worded at present (*i.e.* how to do the problem analysis, how to do the design of solutions etc.), but also for *analytical* purposes, that is, using OPiC in order to study how and to what degree OPiC-standard planning processes have taken place. For instance, what final variables were used? What actors were identified? How were options discovered? What type of management was chosen? That way, we use OPiC as a tool to understand and assess existing planning and policy strategies.

(8) All basic concepts of OPiC are fundamentally simple. This implies that the same OPiC structure may be used at any degree of sophistication: qualitative or quantitative, participatory or expert-based, narrative or computerized. Care should always be taken, however, to spend budgets such that a balanced level of sophistication is reached over the OPiC 'map'. It does not make much sense, for instance, to spend much money on an impact model if in fact the values against which the outcomes should be assessed are very poorly known. Or, to take another example, to spend much money on problem analysis when the social causes of the problem are so poorly understood that there would only be a poor basis to design effective policies.

(9) All the while and even though OPiC is applicable to any kind of environmental problem and explicitly contains an element of searching for opportunities outside a strict problem frame, the framework remains connected with the 'problems look' on issues of environment. If and insofar users desire to put solutions and not problems first, they are advised to also take a good look at frameworks such as Cradle-to-Cradle [26] in which problems have only a background function.

Like any other framework, OPiC is not something to be applied rigidly as if it were a mathematical formula with only one way of doing it. Users will often have to adapt the framework to address the issue and context under consideration, based on its underlying principles.

6. Justification for the Use of the OPiC Framework

Maybe most basically, OPiC facilitates *locally based applications*, as independent as possible from foreign expertise and funding. This appears to boil down to the following two points:

- The structure of OPiC is not only adequately expresses the structure of environmental problems, their explanation and their solution, but also in a way that lies close to basic human reasoning. OPiC reads like a 'story' that mimics as much as possible of what 'everyone' would tell – or at least understand – of how a problem is structured, how it come about and what might be done about it. That way, OPiC is open as possible to participation of local (community, private or NGO) actors in problem analysis and the use and adaptation of local institutions for problem solving.
- OPiC expresses the structure of environmental problem situations in a conceptually compelling manner, so that it is able to work independent from data quality. Thus poor data quality, if coupled with good political will to acknowledge and solve the problem, could result in solutions that may be acceptable to all. In case of higher data quality (evenly or partially), solutions could move from the socially acceptable to the scientifically optimal, without disrupting the basic structure of the underlying analysis.

A basic rule of conflict resolution is that actors should be invited to focus on what they really need, rather than on their personal or organisational positions. Analogously for OPiC, the framework's key concepts focus on values, functions and whole-problem oversight rather than partial or sectoral issues.

- Such a "principled analysis" adopted by OPiC, for instance, use the functions-of-the-environment concept rather than compartments (water, air, etc.) to describe how environmental change links up with societal impacts. OPiC also make explicit what role is played by values (political objectives, norms, standards etc.) in the analysis and solution of the problems at hand.

Individuals and organisations may have multiple roles in problem situations. They may be standard-setting agencies, problem-causing actors, problem victims or creative agents of opportunity – or several of these at the same time. OPiC help, conceptually, to keep these roles distinct and support analysis based on these realities rather than convoluted unclarity.

When part of a problem situation, actors often have a tendency to focus on their lack of capacities rather than on a possible lack of motivation. Lack of capacity, after all, elicits rewards (capacity building etc.), while lack of will does not. Developing countries have plenty of capacity constraints but do not necessarily lack in political will or creative power to find solutions through opportunities. By keeping values and opportunities in clear view, OPiC should facilitate developing country actors to focus on their responsibilities and strengths rather than their constraints.

OPiC framework brings about major improvement in pollution management because it is flexible, adaptable, easy to implement and has economic efficiency, environmental effectiveness and equity as key components, compared to the current frameworks which are generally geared towards end-of-pipe solutions and do not consider most of the features of the OPiC framework. In addition, current pollution management frameworks require quantitative data, and do not consider the causes of the problems, the actors behind problem and how they are related to the problem and the reasons the actors undertake their actions. The frameworks do not provide sufficient information of the functions of the environment and carry capacity of the environment and the windows of opportunities available to solve environmental problems are not fully analysed. OPiC seeks to address all these critical issues that are not fully covered by current pollution management frameworks.

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