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Causal Chain Analysis and Root Causes: The GIWA Approach

The Global International Waters Assessment (GIWA) was created to help develop a priority setting mechanism for actions in international waters. Apart from assessing the severity of environmental problems in ecosystems, the GIWA's task is to analyze potential policy actions that could solve or mitigate these problems. Given the complex nature of the problems, understanding their root causes is essential to develop effective solutions. The GIWA provides a framework to analyze these causes, which is based on identifying the factors that shape human behavior in relation to the use (direct or indirect) of aquatic resources. Two sets of factors are analyzed. The first one consists of social coordination mechanisms (institutions). Faults in these mechanisms lead to wasteful use of resources. The second consists of factors that do not cause wasteful use of resources *per se* (poverty, trade, demographic growth, technology), but expose and magnify the faults of the first group of factors. The picture that comes out is that diagnosing simple generic causes, e.g. poverty or trade, without analyzing the case specific ways in which the root causes act and interact to degrade the environment, will likely ignore important links that may put the effectiveness of the recommended policies at risk. A summary of the causal chain analysis for the Colorado River Delta is provided as an example.

**Understanding the root causes of problems in international waters will help prevent or mitigate these problems.
Photo: JVZ/Science Photo Library**

INTRODUCTION

The Global International Waters Assessment (GIWA) (1) was created in order "to develop a comprehensive, strategic framework for the identification of priorities for remedial and mitigatory actions in international waters (2), designed to achieve significant environmental benefits at national, regional and global levels" (3). The importance of aquatic resources that are shared by two or more countries is enormous. There are 261 watersheds that each flow through the national borders of two or more nations. A substantial proportion (40%) of the world's population lives in these basins. In total, there are 145 countries that have an international basin as part of their territory. The flow of these rivers accounts for 60% of total river flow. The surface of these basins amounts to 45.3% of the land surface of the planet (4). Additionally, half of the earth's population lives in coastal areas and that proportion is expected to grow to 75% by the year 2030. These systems provide humankind with essential services. They supply goods including food and freshwater; they regulate environmental processes like the climate; and they provide cultural benefits. It is no exaggeration to say that these systems maintain the conditions for life on earth.

Establishing priorities for actions implies not only an assessment of the severity of the problems but also an analysis of what can be done to solve or mitigate these problems. Understanding the root causes of these problems, is particularly relevant for the further analysis of actions. Consequently, one of the salient characteristics of the GIWA assessment is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to the creation of more effective societal responses to the extremely complex water-related transboundary problems.

THE GIWA CAUSAL CHAIN ANALYSIS

Causal Chain Analysis traces the cause-effect pathways from the socioeconomic and environmental impacts back to its root causes. Its purpose in GIWA is to identify the most important causes of selected problems in international waters in order to target them by appropriate policy measures for remediation or mitigation. This last characteristic needs emphasis; GIWA's objective leads to an action, i.e. policyoriented causal chain analysis. The success of GIWA in meeting its objective is directly linked to the successful identification and understanding of the forces that truly drive problems in international waters; i.e. the root causes. By understanding the linkages between issues affecting the transboundary aquatic environment and their causes, stakeholders will be better placed to support sustainable and cost-effective interventions.

Unfortunately, the root causes are not always easy to identify because frequently they are far away (both in space and time) from the problems they create. The Causal Chain Analysis of the GIWA methodology was developed to help identify and understand the root causes of international waters problems. The core of the GIWA Causal Chain Analysis methodology is to pinpoint the human activities that produce the problem and then identify the factors that determine the ways in which these activities are undertaken. Two characteristics of the methodology must be underlined. First, due to the fact that there is no universal theory of how root causes interact to create natural-resource management problems and due to the great variation in local circumstances under which the methodology is being applied, the GIWA methodology should be regarded as a framework, rather than as a set of detailed instructions. Second, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA (5). For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

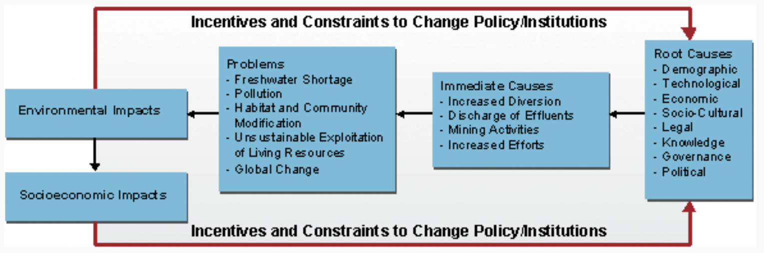

Figure 1. The links between the environment, human welfare and the conditions that facilitate environmental deterioration.

Conceptual Model

A causal chain is a series of statements that link the causes of a problem with its effects. The GIWA causal chains are built for particular sites in order to be able to understand the specific characteristics of problems. GIWA task teams select sites that are representative of the problems they want to analyze or sites that are particularly interesting in analyzing, e.g. hot spots. The starting point of a particular causal chain is the selection of a site, a problem and its associated environmental and socioeconomic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the problem. For example, for the problem of eutrophication, the immediate causes may be, *interalia:* enhanced nutrient inputs; increased recycling/mobilization; trapping of nutrients (e.g. in river impoundments); runoff and storm waters.

Once the relevant immediate cause(s) for the particular system has (have) been recognized, the sectors of human activity that contribute most significantly to the immediate cause have to be identified. Assuming that in our example the most important immediate cause had been enhanced nutrients, then the pressures may come from, among other sectors, agriculture, urbanization or industry. Sector identification is important to understand the motivation for the behavior that is causing the problem. This facilitates the development of interventions and identifies the targets for these interventions. After identifying the most significant sectors of pressure, the root causes that determine those pressures have to be investigated. If agriculture was the sector where the pressure was coming from, what factors could explain human behavior in that sector? What are the objectives and constraints of the decision-makers whose decisions are causing the problem? The methodology offers a nonexhaustive list of possible root causes. Continueing with our example, the root causes may be, among others: economic (subsidies to fertilizers and agricultural products); legal (inadequate regulation); governance (poor enforcement); technology or knowledge related (lack of affordable substitutes for fertilizers or lack of knowledge as to their application).

Once the relevant root causes have been singled out, an explanation, including available evidence, on how they act and interact to cause the problem should follow.

Root Cause Analysis

The fact that there are severe problems (freshwater shortage, pollution, habitat modification and overexploitation of living resources) associated to transboundary aquatic ecosystems begs 2 questions. *i)* How did we get there? *ii)* What can be done about it? This section describes the GIWA framework to help answer the first question. The key methodological aspect is to analyze the factors that shape human decisions (6). The answer to the second question is not necessarily linked to the answer to the first one. Pharmaceutical companies produce many successful products that operate through unknown causal paths on diseases whose origins are not known. However, causal models may be very effective in suggesting the characteristics of successful interventions; especially in complex cases where the problems are embedded in an intricate web of social interactions under institutional constraints and incentives. From this point of view, frequently, the most effective way to address these problems implies the application of several policies, rather than a single panacea. The relative importance and the timing for the different interventions depend, of course, on the local circumstances.

Changes in the root causes can lead to changes in factors that directly affect ecosystems (immediate causes), such as increased water diversion or increased pollution. The resulting changes in the ecosystem cause the ecosystem services to change and thereby affect human welfare. Eventually, the accumulation and (hopefully) the prevention of environmental and socioeconomic impacts also affect institutions.

In order to analyze the causes of problems in aquatic ecosystems, it is essential to distinguish 2 important concepts: natural resource problems and misallocation of natural resources. Given resource scarcity and the fact that the mass of materials flowing into the economic system from the environment has to either accumulate in the system or return to the environment in a transformed way, scarcity and pollution are bound to accompany humankind. On the other hand, misallocation of resources implies inefficiency or wasteful use of resources (in a Paretian sense). The fact that a certain group uses water resources in an efficient way does not mean that the group does not face water problems, e.g. scarcity.

The expression "root cause" is used in a flexible way in the GIWA framework. It refers to the factors that influence human behavior. The list of root causes includes factors that are considered causes of natural resource misallocation, like inappropriate prices and ill-defined property rights, and factors like poverty and population growth that are linked to environmental problems, but that do not necessarily cause misallocation of resources. The former are called causal factors and the latter are called catalysts. The following section analyzes the potential roles of the 2 groups of root causes, i.e. causal factors and catalysts.

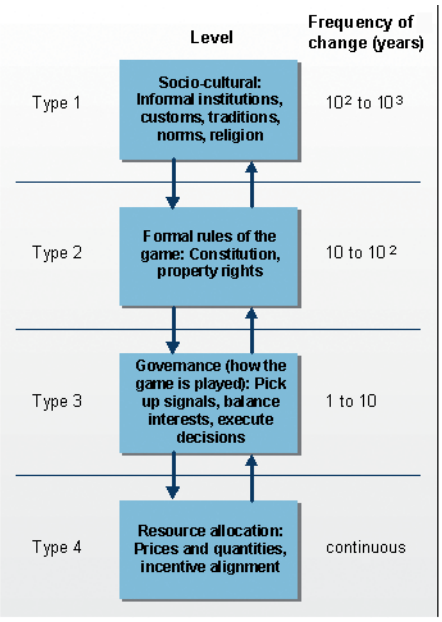

Figure 2. Institutional types and their frequency of change.

Causal Factors

Most water-related problems were created and/or aggravated by faulty mechanisms of social coordination. Consequently, in order to prevent future problems and to solve or mitigate the current ones, we must improve the mechanisms of social coordination that have an impact on water. This principle applies to problems as diverse as pollution, freshwater shortage, habitat modification and overexploitation of living resources, and to coordination mechanisms as diverse as water rights, the pricing system and cultural norms.

Social coordination is carried out through institutions. Institutions are the rules, norms and organizations that make coordinated social behavior possible. Faulty institutions lead to the misallocation of water. This approach facilitates our understanding of the causes that drive water problems and can be used to identify strategic interventions that can be implemented to transform our current institutions so as to be able to promote the sustainability of services provided by aquatic ecosystems.

To analyze institutions it is useful to consider 4 different types of them (7). Figure 2 shows the 4 different types of institutions, their normal frequency of change and their purpose. The solid arrows that link an upper type with a lower type indicate that the former sets constraints on the latter. The dashed arrows that link lower types with upper types represent feedback. Williamson recognizes that "in the fullness of time, the system is interconnected" (8).

Institutions of the first type include norms, customs, mores, traditions and religion (9). Change in this type of institution is very slow and difficult to orchestrate because they display a great deal of inertia — some perform important functions (as with conventions); others symbolize values; many are symbiotically linked to other institutions. Institutions in this category have a pervasive influence on the allocation of resources. Consequently, the way in which traditions and beliefs conform to the basic principles for good water-resource management is the institutional foundation on which the allocation of water-resources is built. Several international conferences (10) articulated and, subsequently, affirmed a set of principles for good water resource management. These are known as the Dublin Principles. The first of them requires that water be considered as a unitary resource within river basins, granting special consideration to ecosystems. This principle is known as the "ecological principle". The second principle is known as the "institutional principle". This principle establishes that water management needs the participation of government, civil society and the private sector. It also gives special attention to the role of women and calls for the application of the principle of subsidiarity. The third principle is referred to as the "instrument principle" and requires that water be recognized as a scarce economic good. Economic good in this context refers to a situation in which the needs and wants of an individual or group of individuals exceed the resources available to satisfy them. In the case of economic goods, choices have to be made and the available resources must in some way be rationed, either by prices or some other allocation mechanism. A mismatch between cultural beliefs and the relative scarcity of natural resources does not bode well for an efficient allocation of natural resources. If, for example, people believe that it is the government's duty to make water freely available for irrigation, despite its scarcity, wasteful uses of water are likely to follow.

The institutions in the second category are the formal rules, like constitutions, laws and property rights. Change is not common in this type of institution, although some historic opportunities do arise from time to time; mainly due to crises of different sorts, like civil wars, occupations, perceived threats, breakdowns, military coups, etc. The way in which people use natural resources depends, among other things, on the property rights presiding over those resources. In this context, property rights refer to a bundle of entitlements that define the owner's rights, privileges and limitations for the use of the resource. Property rights can be vested with different agents; among them: individuals (as in the prototypical capitalist society), the state (as in the prototypical centrally planned, communist society) and in groups of people (like in traditional societies) (11). Each of these prototypes has numerous subtypes and a myriad of hybrids exists as well. By analyzing the impact that property rights has on human behavior, we will be in a better position to understand the underlying reasons for the misallocation of resources and to evaluate the effectiveness and sustainability of interventions.

In market economies a definition of property rights that does not lead to misallocation has the following elements (12):

i) Universality: All resources are owned and all entitlements are described.
ii) Exclusivity: All the costs and benefits derived from the use and ownership of the resource should accrue to the owner, and only to the owner, either in a direct way or indirectly by sale to others.
iii) Transferability: All property rights should be transferable through voluntary exchanges.
iv) Enforceability: No involuntary seizure or encroachment by others should be possible.

Transferability merits special discussion in the case of water. Restrictions on water transfers often lead to inefficient use. A common restriction is the "use it or loose it" principle. Users that could care for conservation, finding ways to use less water (at their own expense), would find their allocations

Box 1. The Colorado River Delta

This text is based on the GIWA Gulf of California draft report. The report is being produced in collaboration with the WWF Gulf of California Program. Parra, I., Albar, M., Reza, M., Barrera, J.C., Muñoz, C., Becerra, M., Boone, A., Vargas, A. and Chia, D. 2003. Gulf of California GIWA Report (unpublished draft).

Habitat Modification Due to Freshwater Shortage: The Case of the Colorado River Delta

The Colorado River and its tributaries provide an essential lifeline to both southwest USA and northwest Mexico. It is born at an altitude of 3048 m in the Rocky Mountains of Colorado and flows for 2333 km into the Gulf of California in Mexico. The Colorado River Delta (CRD) was formed at the mouth of the river in the Upper Gulf of California (Mexico) by sediments that have been dragged along the course of the river since the last glacial period.

The *Law of the River* (an array of legal instruments at local, state, interstate, national and international levels) provides the legal framework for water allocation in the Colorado River. The 2 most important components of the Law of the River are the Colorado River Compact (1922) and the USA - Mexico Water Treaty (1944).

The Colorado River Compact is a contract negotiated among the 7 American riparian states and ratified by the American Congress that apportions the waters of the Colorado for "beneficial consumptive use". According to the USA – Mexico Water Treaty, the USA must deliver 1.9 km^3 yr^{-1} of water from the Colorado to Mexico, in the absence of "extraordinary drought or serious accident" and 2.1 km^3 yr^{-1} in surplus years.

There are 2 major problems in the legal framework that have had a considerable impact on the CRD. *i)* The CR waters are over-allocated (up to 30% by some estimates). *ii)* That ecosystems (including the CRD) are not considered beneficial users of water. The combination of these 2 problems means that the CRD is last in line of a valuable and over-allocated resource. This has provoked major changes to the delta: less silt, fewer nutrients, higher salinity and higher concentrations of pollutants. Erosion rather than accretion is now the dominant physical process in the delta, a very unusual condition. The delta area has had a higher than 90% decrease (from 780 000 ha to 60 000 ha). Unique species are being affected and fisheries and tourism in this area have declined or collapsed. Furthermore, the livelihood of indigenous groups like the Cucapá, has been affected because they are now unable to harvest Palmer's Salt Grass (a wild grain that requires flooding to disperse the seeds).

Even in its diminished state, the delta has richer and more diverse ecosystems than the rest of the river. In the last 20 years, 3 El Niño weather cycles provoked substantial flood flows that reached the delta because there is no capacity to store and manage these flows. The flows have contributed to a revival of vegetation, wildlife, and fisheries. Additionally, the flows have proved that the capacity for restoration of the delta is very high. However, apart from cyclical flows, the delta needs a constant flow. Moreover, some authors predict that the little water that the delta receives today will decline in the future, as increased efficiency in storage and operation will decrease floods to the delta. In addition, population growth, groundwater overdraft and fulfilling tribal water rights in the USA will lead to increased demands on river waters. Consequently, a reliable source of water for the delta must be secured.

How much water does the Delta need? Unfortunately, there is only one study that has estimated the water needed to induce biological responses and to maintain the delta's remnant habitat. According to the study, 2 different flows are needed: *i)* flows of 320 million m^3 every 4 years to support existing vegetation and germinate new stands of native trees; and *ii)* annual flows of around 39 million m^3 to maintain the existing riparian and wetland habitat.

Where will the water come from? Both Mexico and the USA must contribute to the solution. However, in order to increase the current flow from the USA to Mexico legal and governance obstacles have to be overcome. With regard to the legal obstacles, the most important one is that the Treaty of 1944 would have to be amended to allow water to flow from the USA into Mexico in excess of the 1.9 km^3 currently provided by the Treaty. On the subject of governance, a process that assures that the additional flow will be used for ecological purposes would minimize political opposition in the USA to the amendment.

Two facts point at irrigation water as an essential element for the solution of freshwater shortage in the CRD: *i)* Irrigation tops the list of Colorado River water withdrawals (close to 85% of total withdrawals) in both the USA and in Mexico; and *ii)* the great majority of farmers respond to economic incentives. The combination of these 2 facts means that if farmers are provided with the right incentives, enough water could be saved to secure a reliable source of water for the Delta.

Based on this causal analysis, the task team recommended the following short, medium and long-term policy options:

– Lease water rights in Mexico and transfer associated water to the CRD (short term; feasible within the current legal framework).
– Purchase or lease water rights in the USA and transfer associated water to the CRD (medium term; it requires legal changes and the creation, strengthening, of governance institutions).
– Decouple subsidies that increase water consumption (transform them into cash subsidies; long term, giving farmers time to adjust to the real price of water).

affected accordingly. Conservation is therefore discouraged. Another common restriction is known as the "preferential use" principle, by which a hierarchy of uses is established. This principle has at least 2 unintended important consequences. *i)* It reduces the incentive to use water efficiently in the higher hierarchical uses, because users in this category know that they will have priority. At the same time, it discourages the incentives to invest in water conservation by users in lower hierarchical categories because their water would be withdrawn if the needs in higher hierarchical categories increased. *ii)* The "preferential use" principle does not adequately consider the incremental damage provoked by temporary shortfalls. This is an important shortfall because water supplies fluctuate over time and unforeseen scarcities may occur any time. If water transfers were possible the incentives for an efficient use of water would increase. More efficient uses could be achieved if users receiving low incremental benefits from their current allocation would trade their rights to those with potentially higher incremental benefits.

The allocation of groundwater often faces one additional problem related to the lack of exclusivity. Water saved by one user, may be used by someone else because the "saver" has no exclusive right to the water he has saved and thus perceives no personal gain in using water more efficiently. It also has a higher risk of degradation, because use is higher and the watertable level at which resource degradation begins is often unknown.

The Type 3 kind of institutions (13) focus on how the game is played. Although property rights remain important, focusing entirely on them is a partial way to analyze natural resource problems, especially in areas where rules cannot contemplate every contingency and adaptation is important. Institutions in this category perform 3 basic functions (14): *i)* picking signals up; *ii)* balancing interests; *iii)* executing decisions.

The ability to pick up signals is important at several levels: from the ability to monitor results and performances, to the capacity to detect new problems and attract the attention of decision makers. Accountability and subsidiarity are useful principles on which institutions that pick signals up should be founded. Balancing of interests is closely linked to stakeholder participation. The balancing takes place at different levels: congress, government policies, court processes, associations of users, etc. A faulty participation mechanism may render decisions illegitimate. Finally, the 2 previous functions will not be reflected in a more sustainable use of water-resources if the execution of collective decisions is defective.

The 3 functions framework can be used to analyze 2 important processes that impact the use of water. *i)* The way in which environmental considerations and other sectoral considerations are integrated in the policy process. The list of important impacts on the environment that are the result of sectoral policies that did not take environmental considerations into account is long. In the case of aquatic ecosystems, agricultural policy as well as energy and urban development policies may be the most visible. How do these policy processes pick up environmental signals? How do they balance sectoral and environmental interests? How are decisions executed or agreements honored? *ii)* The allocation of water by the appropriate bodies. How do they pick up signals of distress? How do they balance the interests of different users (including indirect users of environmental services)? How are decisions executed?

Type 4 institutions relate to the daily resource allocation decisions that result in the actual prices and quantities of goods and services. The environmental consequences of prices that do not reflect the environmental costs and benefits (i.e. market failure) are well documented. Irrigation water is frequently priced without taking environmental considerations into account. Frequently, due to these "low" prices, irrigation water is often abusively used (15). Low water prices discourage investment in water-saving devices. Furthermore, "too low " water prices increase the demand for irrigation water and exaggerate the necessity of irrigation works. This is not to say that all damage done by irrigation is a consequence of low prices, nor that all the environmental consequences of dams should be attributed to low prices. It just states that in the absence of proper cost internalization, wasteful uses of resources are likely to happen.

Catalysts

Catalysts are factors that interact with environmental degradation. This section analyzes potential links of some of these factors (poverty, demographic variables, trade, and technology) with the degradation of aquatic ecosystems. It is argued that institutional failures are the means through which catalysts degrade the environment. Sometimes catalysts are conspicuously linked to environmental degradation. However, it is difficult to talk about causality in a formal sense.

Poverty. Poverty and environmental degradation have many apparent links (16). The usual hypothesis that links poverty and environmental degradation is that there is a vicious circle between them. The impact of environmental degradation on the poor is well established: it affects their health (the poor have less access to potable water and are less protected against polluted waters than other income groups); it lowers their productivity (through illnesses and diverting labor to collect increasingly scarce fuelwood and water); and it lowers the productivity of their natural resources (17).

Establishing causal links from poverty to environmental degradation is far more complex and debatable. There are many examples of poor communities that have managed their resources in a sustainable way. The impact of poverty on the environment ultimately depends on the alternatives that poor people have to generate income, invest in conservation and procure their food, water and energy. These alternatives in turn depend on institutional, e.g. market access and definition of property rights, and technological factors. Consequently, to understand the linkages between poverty and environmental degradation we must analyze the factors that mould the behavior of the poor in relation to these activities. This analysis must be site-specific due to the high number of factors that determine the relationship between poverty and environment.

Population Growth. Despite the different, loud and categorical responses that the links between population growth and environmental problems provoke, very little theoretical and empirical work supports those responses. We are far from possessing a general theory that explains the relationship between demographic factors and environmental deterioration. Dasgupta (18) analyzes some situations in which fertility decisions persistently produce environmental externalities; or in other words, situations in which the private and the social costs and benefits of reproduction differ persistently. Institutional characteristics are again the link between a catalyst and environmental degradation. The factors that facilitate that fertility decisions provoke environmental externalities are cultural (e.g. conformity), legal (e.g. inheritance laws) and governance related (e.g. erosion of rules to govern the commons).

Again, as in the case of poverty, there is no general model that can explain the numerous links between the environment and demographic factors; the analysis has to be site specific. This is especially important for policy purposes; due to the numerous links between demographic factors and environmental degradation a single variable (e.g. access to family planning methods) is rather unlikely to explain the wealth of potentially important links. As a result policies based on a single instrument (e.g. dissemination of family planning methods) will not be as effective as policies that are based on a clear understanding of the links.

Trade. The links between trade and environmental quality also provoke very vocal responses (19). On the one hand, trade advocates state that open economies use resources more efficiently and that the additional wealth that trade creates increases the willingness to pay for environmental improvements. On the other hand, trade skeptics point out that environmental deterioration increases with trade; that "dirty" industries migrate to countries were environmental standards are nonexistent, low or not enforced; that countries are induced to lower their environmental standards in order to protect their industries; and that despite an increased willingness to pay, the environment may suffer because of irreversible damage. There are at least 4 ways in which trade may affect the environment: scale effects; sectoral (structural) effects; product effects; and regulatory and institutional effects. (20) The impact of each of these effects on the environment is ambiguous; it depends on the legal and regulatory framework, on whether or not prices reflect environmental values and on governance institutions. Consequently, it may be concluded that environmental problems linked to trade are not caused by trade as such but by market failures, inadequate legal frameworks and inappropriate governance. Once more as in the cases of population growth and poverty, the specific characteristics of each case have to be understood in order to implement successful interventions.

Technology. The links between technological change and environmental quality have received considerable attention in the recent past (21). Researchers have analyzed how technological change affects the environment and how environmental variables, e.g. regulation, affect technological change. GIWA case studies focus on the reasons why environmentally friendly technologies are not used.

Lack of enforcement of environmental regulations is the first, obvious, potential explanation. Insufficient information is another natural explanation. Information is a public good and as such markets will, in general, under-provide it. The way in which sectors are organized may also pose a problem for the efficient diffusion of environmentally friendly technologies, e.g. fishermen may get their gear from processing firms or from traders. Uncertainty is another potential reason for the slow adoption of environmentally friendly technologies. Producers and consumers may wonder whether the new technologies will perform as expected. Lack of access to credit to finance the acquisition of innovative technologies may also play a part, especially in the case of poor producers. Finally, cultural conformity and inertia may also be part of the explanation to the slow (or non) adoption of innovative environmentally friendly technologies. Yet again institutional conditions determine the environmental impact of a catalyst.

CONCLUSIONS

In order to be able to develop priorities for actions in international waters, the severity of the problems and the potential policy options have to be assessed. Effective solutions to these problems will likely rely on a clear understanding of their root causes. The GIWA framework to analyze root causes is based on the identification of the factors (institutions, income levels, demographic factors, technologies, etc.) that shape human decisions with regard to the use of goods and services that aquatic ecosystems provide. Two groups of factors are proposed by the GIWA Causal Chain. The first group consists of social coordination mechanisms (institutions), including cultural beliefs; laws and regulations; governance mechanisms; and markets. Faults in these mechanisms may lead to inefficient (wasteful) uses of natural resources. The second group consists of factors that do not cause wasteful uses *per se* (poverty, demographic growth, trade and technology) but expose and aggravate the faults of the first group. Diagnosing simple generic causes, e.g. poverty or trade, without analyzing the specific ways in which the root causes act and interact to degrade the environment, will likely ignore important links that may put the effectiveness of the recommended policies at risk.

References and Notes

1. For the background and rationale for the creation of GIWA see Daler and Hempel, *Ambio 33*, 2–6.
2. The term international waters, as used for the purposes of the GIWA, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems. GIWA 2003, *Regional Assessments Vol. 1*.
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4. Wolf, A. 2002 The importance of regional cooperation on water management for confidence building: Lessons learned. Paper presented at the 10th OSCE Economic Forum on Cooperation for the Sustainable use and Protection of Quality of Water in the Context of the OSCE. Czech Republic.
5. This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.
6. Root causes refer to the factors that shape human behavior in the sector in question. Root causes, in this sense, interact among each other. Consequently, GIWA's root causes are not single "primary" causes.
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10. Among them: The United Nations Water Conference in Mar del Plata in 1977; the International Conference on Water and the Environment in Dublin in 1992; and the Earth Summit in Rio de Janeiro in 1992.
11. Open access must be distinguished from common property. In the latter, sets of rules exist for the management and (potentially) sustainable use of the resource.
12. Listing these elements is intended to describe the characteristics of an efficient definition of property rights and its institutional implications. Easy prescriptions to privatize (or to give governments the control of) natural resources are likely to fail.
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