PROTECTING WATER RESOURCES: POLLUTION PREVENTION

Thematic Background Paper

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PREFACE AND SUMMARY

This thematic background paper "Protecting Water Resources: Pollution Prevention" for the International Conference on Freshwater in Bonn in December 2001 is a collection and analysis of relevant information on pressures, state and responses of both groundwater and surface water pollution with special emphasis given to regional conditions, frames and problems. To point out success stories and lessons learnt, case studies have been selected underlying the following criteria:

- *Regional balance*
- *Regional country- or continent-specific solutions and approaches*
- *Special reference to income or development level*
- *Coverage of polluters*
- *Political instruments (e.g. environmental quality objectives, river basin management)*
- *Legal instruments (e.g. water quality agreements)*
- *Economic instruments (e.g. charges, subsidy reforms, tradable permits)*

The case studies were chosen according to the key messages of this paper, which can be summarised as follows:

Water pollution is a global problem, which differs with levels of development. In general terms, water pollution has severe impacts on the usefulness and value of water resources, with negative impacts on ecosystems, fisheries, food production, health and social development, and economic activities. Water pollution can cause or aggravate tension and conflict, among water users and even between countries.

Water shortage is very often induced by water pollution (many centres of population are located on rivers), since polluted water unsuitable for domestic, industrial or agricultural use represents a net loss of water resources. Water shortage in dry regions are often caused or aggravated by economic activities, including agriculture, not suited for the local conditions. As a rule, such activities are in turn heavily polluting.

There is no general "water pollution". Concerning water pollution pressures, distinctions need to be made between different kinds of pollutants:

- *persistent substances, which are always dangerous and must be avoided or at least reduced to the minimum possible (substance bans or restrictions on their trade and use including substitution policies, and technology-derived emission standards are particularly effective instruments as they stimulate technological change),*
- *natural organic matter demanding oxygen, which can be degraded bio-chemically in the natural environment provided the pollution levels are not too high and other risks are well controlled*

(integrated water protection planning is suitable if it includes all relevant point and diffuse sources and considers seasonal and other variations in water flow),

- *nutrients which feed excessive growth in water bodies leading to eutrophication, and can make water unfit for human consumption and other uses (more sophisticated integrated water protection planning is suitable here).*

Water pollution is partly driven by inadequate economic development, especially industrial development, and uncontrolled urbanisation. More recently, pollution from agriculture and aqua-culture has gained prominence.

The state of water pollution has been difficult to estimate as information about different regions, pollution sources and pollutant categories is often patchy and disperse. General trends are, nevertheless, obvious. Pollution pressure on water resources has decreased in some industrialised countries, especially pollution from point sources. Problems persist, however, in relation to diffuse sources and ubiquitous products. In economies in transition, pressure has also declined, largely as a result of industrial decline. In developing countries, pressures increase, in some cases considerably, because of a mismatch of industrial expansion and environmental policies. Pollution from domestic sewage connected to rapid urbanisation and the lack of accompanying wastewater works also remains a major environmental challenge. World-wide, population increase, trade liberalisation and globalisation, potentially contribute to the unsustainable use of water resources and water quality degradation when combined with inadequate planning and inadequate financial resources for the development of strategies that protect the poor.

The impact of water pollution depends on the levels of pollution, the (mix) of pollutants, the ecosystem or population affected, and the economic activity impaired. Social and economic security, which is interconnected with environmental security, are significantly impaired by increasing levels of water pollution. To give an example of the external costs of water pollution, the drinking water supply and consequently public health are already impaired or at risk in developing and increasingly in industrialised regions. The effect of the exposure of aquatic life to freshwater pollution is made obvious by the decline of freshwater species, and especially of fish catches in inland and coastal waters, which directly affects self-sufficient fishing communities and riparian settlements. In short, all expressions of human economic (agriculture, industry, tourism, traditional crafts etc) and social activities are affected by the rising water pollution leading to real and potential loss of development opportunity with the poor being affected to the greatest extent.

Policy responses[1] always involve the setting of norms (for the protection of a "common property" belonging to the (often open) community of water users), and their imposition on that community or the larger society, although the details of approaches vary considerably and depend on the roles of different levels of state. In all cases, policy responses to water pollution make use of at least three types of approaches and instruments, which complement and reinforce one another:

- *Planning, meaning a formalised process of identifying sources of pollution, pollutants and trends, actual and possible impacts, and measures for mitigating pollution. Planning can take the form of administrative co-ordination or it can be a societal dialogue between agencies of the state and (representative) members of the public, or it can occur within more or less formal water users' associations as a consensus-building process.*

- *Police powers, meaning monitoring (of water quality), inspection (of installations, products or production practices) and law enforcement (against polluters) by environmental authorities, fiscal authorities, police and prosecutors, depending on the circumstance. The trend is towards requiring a permit for emissions to water bodies, and making that permit conditional on a number of factors, such as minimum requirements for pollution control.*

- *Economic instruments, such as contributions (e.g. to water user associations), charges, taxes, prices and tariffs for water services, liability and tradable pollution permits. These instruments usually fulfil a financial function (i.e. financing specific water management activities or facilities such as sewerage or sewage treatment plants), and always have an incentive effect which can*

[1] *This background paper focuses on the policy, planning and strategy aspects of pollution prevention and protection of ecosystems. Technological and direct responses, following the planning and decision-making phase, such as building of sewage networks, afforestation, biofertilisers, are not within the scope of the paper.*

purposefully be used to influence polluters behaviour. In many cases, economic instruments also have a fiscal function in that the revenue goes in part – and rarely as a whole – towards general public budgets. All economic instruments have information functions and effects, and raise awareness and influence behaviour quite effectively as a result.

In water policy, including water pollution control, institutions such as social norms, cultural values and even taboos play an important, albeit often unconscious, role.

To summarise, clean water is a public or common (or "club") good and the effectiveness of water pollution control depends in large part on the suitability, stability and adaptability of governance structures and institutions. In practice, water pollution control measures and policies are administered in conjunction with other water resource protection and management functions. Instruments may be specific to addressing water pollution, but the organisations involved usually are not. Because of the public good character of water resources, the transparency of decision-making, the access to information and justice (for conflict resolution) and the involvement of water users is paramount in order to provide democratic legitimacy ("Give the victims a voice"). This applies especially to those water users directly or indirectly affected by water pollution, (elected) representatives of the affected population, and to civil society organisations acting for public-interest goals (in essence non-profit advocacy NGOs). As in all cases where a public interest has to be protected against individual action motivated by private gain, there is a risk that corruption leads to ineffective implementation of water (protection) policies and inefficient results. The democratic and judicial accountability of decision-makers therefore must also be guaranteed. Additionally, adequate and properly managed financing of pollution prevention is of utmost importance for the success of political, co-operative and legislative approaches to resolve the problem of water quality degradation.

0 INTRODUCTION

"*Filthy water cannot be washed*" (Proverb from West Africa)

At the 1992 Rio Earth Summit, the main expressed problems affecting water quality and aquatic ecosystems were untreated domestic sewage, uncontrolled industrial discharges, deforestation and poor agricultural practices that result in soil erosion and leaching of nutrients and pesticides. Public awareness regarding the protection of the freshwater resources as well as monitoring of the ecological and human health effects were also considered inadequate. Agenda 21, the plan of work adopted to conserve and protect the environment, called for the adoption of a catchment management approach and the "polluter pays" principle as well as for immediate action on ecosystem restoration and monitoring, groundwater protection, treatment facilities for domestic sewage and industrial effluents and rational use of fertilisers and pesticides (chapter 18).

During its 6th session in 1998, the UN Commission on Sustainable Development noted, that since Rio marked improvements in water quality had occurred in a number of river basins and groundwater aquifers where action had been taken. However, overall progress had not been sufficient to reduce general trends of deteriorating water quality and growing stress on freshwater ecosystems.

Today, the unsustainable trends prevailing at the time of Rio and CSD-6 have not been reversed. Global co-operation has proven especially difficult on the issue of freshwater access and protection. Pollution of freshwater still remains a major cause of global concern (16) and a threat to aquatic ecosystems as recently stated in the Ministerial Declaration of the 2nd World Water Forum (2000).

More than one billion people still lack access to clean drinking water, while approximately two and a half billion do not have adequate sanitation services (55). According to a survey conducted for the report Global Environment Outlook 2000 (16), the most frequently cited environmental issues of importance in the 21st century by scientists in 50 countries were water quality and quantity along with climate change. Keeping in mind the continuous increase of the human population and the unprecedented urbanisation and industrialisation of the developing world, pollution of freshwater is bound to accelerate.

1. CURRENT SITUATION

Although only 10% of the renewable water resources are currently withdrawn, and only 5% consumed, there are still significant problems concerning human water use. Human activities are degrading the quality of much more water than that withdrawn and consumed (6). Developing countries which combine high water stress with low per capita income are especially vulnerable to water pollution. The majority of these are found in arid and semi-arid regions of Africa and Asia, use most of their available water supplies for irrigation and suffer from lack of pollution controls (3).

1.1. Pressure

1.1.1. Pollutants

The main chemical, physical and microbial factors negatively affecting water quality include:

- **Organic pollutants**. They easily decompose in water and consume dissolved oxygen, leading ultimately to eutrophication. They mainly originate from industrial wastewater and domestic sewage, as well as from seepage of old and new landfills.

- **Nutrients**. These include mainly phosphate and nitrate and their increased concentration can lead to eutrophication. They originate from human and animal waste, detergents and run-off from agricultural fertilisers.

- **Heavy metals**. Such pollution tends to be localised around industrial and mining centres. Heavy metals also originate from military activities and through leaching of decommissioned industrial sites and former military areas.

- **Microbial contamination** from bacteria such as *E.coli*, protists and amoebae that comes from untreated sewage as well as animal husbandry.

- **Toxic organic compounds**. These comprise industrial chemicals, plastics, dioxins, agricultural pesticides, oil and petroleum (group of hydrocarbons), and polycyclic hydrocarbons generated from burning of fuel. The group of persistent organic pollutants (POPs), such as endocrine disrupting chemicals, cyanotoxins, and organotin compounds contained in antifouling paints, continue to be used in large quantities (9). Many POPs are difficult and costly to analyse and monitor, therefore their potential effects on humans are difficult to establish (30).

- **Traces of chemicals** and **pharmaceutical drugs** from medical waste are hazardous substances that are not necessarily removed by conventional drinking water treatment processes. They are now being recognised as carcinogens and endocrine disrupters and pose a great threat to water quality (6).

- **Suspended particles**. These can be either inorganic or organic matter and originate mainly from agricultural practices and land use change such as deforestation, and conversion to pasture at steep slopes leading to erosion.

- **Nuclear waste**. Nuclear waste leaks into aquifers and surface waters are also a major threat to water resources, especially in the transition economies of Central and Eastern Europe (6).

The following processes, which are intensified by unsustainable human activities, also contribute to significant levels of water pollution:

- **Salinisation**, mainly occurring in arid and semiarid regions. Although it can also occur naturally, unsustainable irrigation and inadequate drainage promotes secondary salinisation. It can also be the result of irrigation with salt water, after freshwater has been replaced in coastal aquifers due to over-abstraction.

- **Acidification**, which is connected to the lowering of the pH of the water due to sulphuric deposition produced by industrial activity and also urban emissions.

Table 1. Main pollutants affecting w ater quality and their main sources.

Pollutants/Source	Industry	Human settlements	Agriculture	Others
Organic pollutants	+	+		
Nutrients (nitrate, phosphate)		+	+	animal husbandry
Heavy metals	+	(+)		mining, military activities
Microbes		+		animal husba ndry
Toxic organic compounds (chemicals, pesticides, POPs)	+	(+)	+	
Pharmaceuticals and trace chemicals	+			
Suspended particles	+	+	+	land use change
Nuclear waste	+			

Obviously, there is a diverse range of water pollutants, each of which is hazardous in different concentrations and originates from diverse activities. Nevertheless, water bodies, have their own self-purification capacity, which depends on a variety of factors such as water volume, flow and chemistry. Aquatic ecosystems and communities interact in a harmonised way to keep the physico-chemical status of a water body in balance. Thereby, water pollution actually refers to the contamination of the water bodies and their substrates when pollution exceeds their self-purification capacity or their sink capacity for pollutants. Considering this, the aquatic ecosystems revival can be achieved not only through pollution control measures but also through the ecological restoration of habitats and floodplains, which can significantly contribute to boosting self-purification and improving water quality.

1.1.2. Main Polluters

The industrial sector is responsible for the release of a wide array of pollutants and hazardous substances through wastewater, emissions and leaching of industrial installations. Decommissioned industrial sites and land contaminated by past industrial activities are also a significant source of pollution (38). The accidental episodic release of hazardous industrial pollutants into freshwater is increasingly threatening the environment especially in countries where the respective safety regulations for industry are vague or lacking.

Although some industrial pollutants have been reduced through strict legislation and technology investments in industrialised countries during the last 20 years, problems are now increasingly arising from new chemicals and new sectors of industrial activity. An issue of increasing concern is also the dumping of waste chemicals in developing countries, where legislation is not as strict yet.

Human settlements and particularly cities of high population density and uncontrolled growth are 'hot-spots' for concentration of pollution (Table 1). Informal urbanisation, and uncontrolled urban agglomerations in the developing world combined with decreased natural sinks, e.g. drained wetlands around urban centres, harm extensively the local water resources. New and old landfills serving human settlements also consist sources of pollutants through leaching. Many megacities today are properly connected to waste-treatment plants but in many others located in rapidly developing countries, the sewer network and treatment facilities are not growing as fast as the population.

Finally, the extensive, centrally planned and rapidly modernised agriculture is a major polluter of water as a result of unsustainable land management and cultivation systems. The major water pollution issue is that of non-point sources. Often, pollution from agriculture, inadequate urban wastewater treatment and management of urban run-off are considered as larger problems than industrial pollution, in terms of absolute quantity of pollution loads, the geographical extent of the pollution problem and the relative difficulty of controlling these sources of pollution (33). Recently, aquaculture has also gained prominence as a source of freshwater pollution.

1.2. State

1.2.1. Regional Overview of Water Pollution

The global magnitude of pollution has been difficult to quantify because of scarcity of information. However, there are trends in water pollution world-wide which have changed greatly over time. The type and extent of water pollution is closely linked to water use and levels of socio-economic development. [2]

The industrialised countries have faced several freshwater pollution problems involving domestic, industrial and agricultural wastes. Over the last 20 years, industrial waste and discharges of many toxic substances have begun to decline, primarily through technical solutions and heavy investments in end-of-pipe technologies (7) within a framework of prohibitions and limit values, as applied for instance in Japan. Municipal waste treatment plants have also considerably reduced faecal contamination (25) and organic pollution from untreated human wastewater (3). However, problems still remain concerning pollution from non-point sources (acidification, organic micro-pollutants, nitrates) and groundwater contamination (7) by nitrate and heavy metals. Contaminated sediments also appear to pose a great threat as they form chemical "time bombs" that pollute surface and groundwater for many years after their original contamination (9).

In the European Union (EU), eutrophication and organic pollution are still major water pollution problems. There has been a reduction in phosphorus levels and organic matter in recent years but nitrate levels still remain high (30). Although pollution trends in western European rivers have declined significantly, in the southern Member States pollution from untreated sewage continues to degrade water quality (20). Other significant water pollution issues in the region are acidification, groundwater contamination and elevated POPs concentrations (30).

[2] *For more detailed information and data on water pollution in individual regions and countries, see Annex A (Part I)*

In North America, nitrate pollution will remain one of the most serious water quality problems, if present trends continue (3). Agrochemical run-off is the main source of groundwater and surface water pollution in the agricultural regions. Although, drinking water quality has improved in recent years, new pollutants such as industrial chemicals, increasingly threat and contaminate the water supplies (16).

In economies in transition, pressure has declined largely as a result of industrial decline. In many regions in Eastern Europe, however, there has been steady deterioration of water quality over the past three decades. Many cities have suffered from poor drinking water quality, which has deteriorated after the beginning of the economic transition, given that many local municipalities simply lack the funds to construct municipal wastewater treatment plants (16). The resumption of economic growth and industrial activity may result in increasing water pollution (16).

Rapidly developing countries such as India, Brazil and China are experiencing simultaneously all water pollution problems experienced sequentially in time in the industrialised countries, while they still struggle to deal with problems of water supply and sanitation (39). In the least developed countries the lack of sanitation leads to problems of pathogens and organic pollution (39). Deterioration of water quality is a major environmental challenge in arid regions such as Africa and West Asia (16). In many regions, wastewater treatment is still not the norm, with 90% of wastewater being discharged untreated (25). Concerning agricultural pesticides, their use is extremely variable, ranging from zero in large parts of Africa, to high dosage in intensive agricultural areas of Brazil and plantations of Central America (52). Banned toxins such as DDT are still widely manufactured (by northern-based multinationals) and used in the developing world (8).

In Latin America, the main polluters are human settlements and their untreated waste, accompanied by industrial development around large metropolitan areas (16). The food industry appears as the main pollutant in all south American countries followed by paper mills, chemicals (57) and mining (16). Agricultural pollution is also significant in certain regions where pesticides and fertilisers are applied extensively.

In Africa, eutrophication is and may remain one of the main threats to water quality under the projected doubling of fertiliser consumption by 2020 (20). In some regions, nitrate loads in suburban groundwater wells are 6-8 times the WHO acceptable levels (16). Untreated industrial and domestic waste as well as leachates from diffuse dumps cause a major and persistent health problem. If present trends continue, Africa will be threatened by a sharp increase in untreated sewage, eutrophication, pollution from oil and gas fields (9) and industrial effluents mainly generated by small-scale industries dispersed in land urban areas (56).

In the region of Asia and the Pacific, socio-economic development and water pollution issues vary greatly. An array of pollution pressures are exerted on water resources including high sediment loads, hazardous and toxic waste from industrial sources, high eutrophication rates and agro-chemicals, as well as untreated waste from urbanised centres (16, 7, 9).

In Southeast Asia, industry is the main source of water pollution but untreated domestic waste, chemical residues and animal waste increasingly affect water quality (16). Eutrophication is taking threatening dimensions (16), due to excessive levels of nitrate. The problem of pathogenic agents is also very acute since only 10% of the sewage is treated at primary level (16). Moreover, localised problems with natural pollutants, as the arsenic contamination in Bangladesh and India, have become acute due to inappropriate planning and management.

In Western Asia, the major water quality problem identified is salinity caused by widespread irrigation (3) and over-abstraction. In certain areas, untreated wastewater, pesticides, and high nitrate concentrations impair water quality seriously.

1.2.2. Water Pollution in Relation to Other Developments

In the light of world population increase heading to 8.3 billion by the year 2025, water pollution problems are expected to worsen, especially in the rapidly growing urban areas of developing countries. While the population load doubles, the pollution load tends to increase 5-10 times.

The massive abuse and pollution of the internal waterways in most developing countries has also been one price of the process of globalisation. The competitive international market forces small-scale farmers to use more fertilisers and pesticides to remain competitive and maximise the productivity of their land. This, however, leads to increasing water and soil pollution while burdening the farmers with increasing financial debts (44). Several national governments are also increasingly tempted to lower environmental regulations in order to remain competitive within the new economy. As a result, they are left with reduced regulatory capacity to prevent further pollution (8).

Regarding the industry sector, an increase in economic growth of trans-national companies can lead to an increase in the production of substances hazardous to water resources (59). This has become obvious from the expansion of the polluting mining industry, for instance..

However, globalisation and the environment should not be necessarily in conflict. Globalisation can possibly help to overcome financial constraints for the development of pollution prevention technologies and strategies by easing negotiations and co-operation between international private and public partners.

1.3. Impact

1.3.1. Impact on the drinking water supply

Poor quality of surface and groundwater has become a threat to supplies of drinking water world-wide. In industrialised regions, excessive nitrate spread over farmland (20), bacteria, hazardous liquid waste and trace chemicals pose an increasing threat to drinking water supplies. Nevertheless, although several water supplies have been judged unfit for drinking in prosperous regions such as US California (29) and Japan (16), top priority regarding drinking water quality needs to be given to developing regions, e.g. parts of Africa, Latin America and Southeast Asia (3). There, the drinking water supply is more extensively affected by sewage influx, faecal contamination, pesticides, nitrates and industrial discharges threatening with public health risks. The increasing contamination of groundwater due to persistent types of pollutants that are not infiltrated by the soil, is of particular relevance to global water security. In most Asian countries, groundwater provides more than 50% of domestic water supplies (20). Moreover, groundwater pollution is *essentially permanent*. Water entering an aquifer remains there for an average of 1,400 years compared to only 16 days for rivers (29). Experts project that groundwater pollution will ultimately dwarf surface water pollution in scale, scope and threat to humanity (45).

1.3.2. Impact on ecosystems

The health of rivers, lakes, estuaries, coastal systems as well as marine resources is threatened world-wide by water pollution issues, such as *eutrophication, toxics (pesticides, POPs), heavy metals, acidification and siltation*. Their main effects are ecosystem dysfunction, loss of biological diversity, alteration of aquatic habitats and contamination of downstream and marine ecosystems[3]. Ecosystem impacts are similar in polluted aquatic ecosystems world-wide, and are particularly acute near centres of human activities.

1.3.3. Economic impacts of water pollution

There is real and potential loss of development opportunity because of diversion of funds for the remediation of water pollution in several developing countries. If remediation costs exceed economic benefits, lending institutions may regard development projects as no longer being creditworthy (52). In developed countries, investments in water pollution abatement and control will likely double to 250 US$ per capita per year by 2025 and most likely consumers instead of polluters will pay most of these costs (9). The purification costs are even higher for contaminated

[3] *See Annex A (Part II), for more detailed description and regional data on certain water pollution issues that affect ecosystems*

groundwater.[4] In this context, the following message needs to be delivered to decision-makers: the cost of water pollution is higher than the cost of its prevention, and neglecting water pollution control entails high social and environmental costs.

Inadequate access to water of reliable quality is both a cause and a consequence of poverty in developing regions such as Africa. The high incidence of communicable diseases due to lack of sanitation reduce vitality and economic productivity. Moreover, in many developing countries, poor people pay particularly high prices for water of unknown quality (58).

Food resources are also threatened by a damaged agricultural production, in terms of decreased crop yield and quality, through the use of salinised and polluted water for crop irrigation (53). Aquatic ecosystems will not be able to provide the essential goods either. The damaging of commercial fisheries impacts self-sufficient fishing communities and riparian settlements. The decline of commercial fish production is in turn expected to exacerbate demands for protein from livestock production and agriculture (52).

In some parts of the world, water has also been judged unsuitable even for industrial purposes (3, 8). This can have a significant impact on industrial productivity and a respective impact on the economy of industrialised or rapidly industrialising countries. The profitable tourism "industry" is also negatively affected by water pollution and consequent esthetical degradation.

1.3.4. Impact on human health and social security

3-4 million people die each year of waterborne diseases world-wide, including more than 2 million children who die from diarrhoea (6). Urban populations in developing countries and particularly in urban slums are groups especially vulnerable to the negative health impact of water pollutants. The costs on human health protection and preventative medicine are significant.

The degradation of water resources reduces social security. The impairment of water resources in regions where poverty already affects a great part of the population, can lead to greater social inequity and poverty intensification. Poor quality water also forces women, who are the main collectors of water, to travel long distances in order to obtain clean water, thus negatively affecting their time management.[5] As far as regional and international security is concerned, degradation and lack of respect for water resources may exacerbate social conflict. Conflicts between upstream and downstream nations or communities shall increase, if unwise and segmented river basin management continues.

1.4. Responses to water pollution

1.4.1. Political responses

One of the political approaches concerning water pollution abatement has been the adoption of Environmental Quality Objectives (EQOs), which essentially define target values for key ambient quality parameters and are subsequently used to evaluate existing environmental conditions (40). Once quantified goals have been prepared, the critical step is to develop an improvement strategy. EQOs have been adopted in several cases and regions successfully, as in the river Thames restoration (Box 1). Developing countries have also adopted EQOs, but often in the form developed by western water quality agencies, which may not always be appropriate. Criteria developed in temperate ecosystems should be used with care in African, south Asian, or Latin American countries, due to the large differences in chemical behaviour in different climatic conditions (52).

In other cases, the uniform standards approach is adopted, currently used both in the US and the EU, which serves to set limits on a common co-ordinated basis to deal with water pollution problems. Notably, it has achieved significant improvements in levels of wastewater treatment in

[4] *See Annex A (Part II), for examples and numerical data on the economical impacts of water pollution*

[5] *For a detailed overview of the gender aspects and women's role, the reader should refer to the thematic background paper "Integrating Gender Perspectives: Realising new options for improved water management"*

the industrialised countries. However, the costs of implementing this approach have been rather high.

Recently, the river basin management approach has been introduced, as also adopted by the new EU Water Framework Directive, and is increasingly being considered as a management option for rapidly developing countries, such as Brazil (61). Water quality and ecosystems protection are viewed as an important element of integrated river basin management that involves all stakeholders. Nevertheless, the river basin approach requires a certain level of planning and institutional structure. On the one hand, the latter may take time to develop (40) where administrational infrastructure is weak. On the other hand, weak existing structures are easier to transform and adapt to a river basin approach. In general, for most political approaches, experience shows that organisational structures should not be transferred from one region to the other. Instead, organisation of water resources management systems, in developing countries especially, should be founded on existing institutional foundations adapted to the prevailing economic and natural resources (62) and should incorporate all major stakeholders.

Many of the responsible bodies for water-related services, in developing countries, have centralised structures which inadequately deal with issues of consultation and interaction with other stakeholders, especially users (55), and have proven to have a weak effect regarding water pollution control. Responsibilities and resource management need to be decentralised and allocated to the lowest appropriate administrative level, according to the concept of subsidiarity (55). This should be reinforced by legislation that establishes specialised regional agencies, which then have the incentive to inspect premises and impose various penalties (40).

Most of the responses to water pollution described above, such as EQOs and uniform standards, have so far been on the political agenda in the western developed world. In most developing countries, water pollution has not been a major topic of political debate yet and therefore political instruments have been scarcely implemented.

1.4.2. Legal responses

Rigorous but phased legislation with realistic timetables and enforcement of technical standards can act as key catalysts of change in water pollution abatement (34).

Permits and licenses are one of the legal instruments which are used, in principle, for all water uses. They are granted on certain conditions, such as that minimum performance requirements for pollution abatement are being met in case of effluent discharge. Management practices such as monitoring (inspections) can be imposed when a permit or license is granted (63). Nevertheless, inspection is limited even in developed countries and lack of “policing” often lies at the heart of failure to reduce water pollution (12).

Monitoring is also developed and planned on a legal basis. In many cases, the planning and use of monitoring has been inadequate. Consequently, effective solutions are difficult to derive and enforcement is difficult to achieve (39). However, the development of an information base is a precondition for an effective water policy, and existing monitoring programmes need to be better adapted to the management requirements. Many countries tend to spend many financial resources producing data that are not closely linked to decision-making and some times not used at all (51). In developing ones, this is often the result of inappropriate technology and knowledge transfer from the developed countries (52).

Emission-based standards and the setting of clear objectives at a consistent level of water quality at a national or international level are also legally adopted. In some countries, national water standards do not exist and should be established. For instance, in Pakistan, national water standards are now being developed. In developing countries, emission-based standards have not been very effective so far, since they are rarely monitored and only occasionally enforced. It is also incorrect to adopt western water quality objectives that are inappropriate to the level of development and economic state of the adopting country.

Legal agreements, at the national (Water Law, Water Acts, Directives) and international level (conventions), are often used to protect waters from certain pollutants by planning for reduction, phase-out or banning at a national, regional and international level. Legal agreements are also

used to establish regional pollution reduction strategies and co-operations, as the new declaration for the protection of the Carpathian-Danube region. The latter has been signed by 11 central and eastern European countries in 2001, committing them to develop national policies to decrease pollution in the Danube (68). Moreover, legal frameworks increasingly address the environment as a unit, dealing not only with water pollution issues but also ecological and hydrological aspects, as in the case of the EU Water Framework Directive.

Issues of liability and effective punishment under violation are also legal approaches that ensure enforcement of pollution control (fines and penalties). Unfortunately, in the case of violation, most western legal systems today provide corporations with immunity from criminal penalties and civil law is increasingly considered to recover damages (12).

1.4.3. Economic responses

Recently, the emphasis of policy regarding water pollution has shifted towards environmental management, using incentives, cost-effective strategies and improved performance to achieve sustainability (40). Within this context, many developing countries in Latin America and Asia have been experimenting with economic instruments. These market-based strategies, such as charges, environmental taxes, pollution levies and tradable permit systems tend to be flexible for the industry, enabling the polluter to choose the most economical option for reaching a desired target (40). Water charges have been mainly used to combat point sources of pollution and in particular industrial waste in both developed and developing countries. Tradable water pollution permits have been used to combat nutrients, organic pollution and salinity (47). Subsidies are also increasingly used to combat water pollution. Meanwhile, subsidy reforms to remove "perverse" subsidies that encourage water pollution have been initiated (Box 12) in some regions.

1.4.4. Social responses

Public participation in water resources protection is slowly gaining attention and is usually favoured by a decentralised approach based on regional units. Public awareness, education and dissemination of water culture are important elements of a sustainable water pollution abatement strategy. It is recognised that local and regional cultural values and taboos are often significant components of polluting activities but they can also play an important role in water pollution control, given the right training and facilities. In Asia and the Pacific, for instance, despite efforts to combat water pollution at a political level, public awareness levels regarding water pollution and its abatement remain very low (16).

2. SUCCESS STORIES AND LESSONS LEARNT

2.1. Political approaches

Ineffective regulatory oversight, institutional failures and lack of political commitment are often quoted as some of the most significant causes of water pollution problems. Therefore, a critical step towards the protection of water resources is the creation of will and commitment among political parties at all levels, to seriously invest human and financial capital in the protection of freshwater and related ecosystems and to consider the polluter pays principle in all relevant water policy formulation.

Several political approaches to water pollution have been developed that have already proven or have potential to be successful such EQOs and river basin management. Decentralised decision-making systems, characterised by self-government and self-financing, have also proven successful in achieving the protection of water resources (64) (see case in Colombia **Box 3** and Israel, **Box 10**). Willingness to pay may also increase significantly if payments are made to local institutions that can be held accountable for delivery of services (9). Nevertheless, regional and interregional structures still remain important for issues such as diffuse agricultural pollution that affect local water quality but require a centralised approach (64).

2.2. Legal instruments

Legal instruments, the so-called command and control strategies have been used widely over the past 20 years and still remain important in several high-income as well as developing countries (20). Several binding frameworks, such in the Great Lakes of US and Canada (**Box 5**), and legal decisions (banning of insecticides in Indonesia combined with farmers' training programmes, **Box 9**) have been used with success in several regions.

The approach of command and control, however, is yielding less benefits per unit of expenditure in some industrialised countries, while developing countries often lack the necessary preconditions for implementing pollution control measures (40). Even where court orders have sentenced closure of polluting industries, these often have silently reopened for economic and employment reasons. Problems that decrease the effectiveness of command and control in the developing world, as in the region of Eastern Antioquia in Colombia (**Box 3**), include the unmanageable costs of monitoring, the lack of legislation with adequate enforcement possibilities, corruption, lobbying and a lack of adequate administration infrastructure (42). Authorities often simply lack the ability to closely monitor each industry for their discharge limits and offenders get away unpunished (24).

In some cases, the effectiveness of traditional enforcement measures such as inspections and penalties has been successfully strengthened through combination with other instruments such as public disclosure programmes (see case of Canada, **Box 11** and Indonesia, **Box 7**) and economic instruments (see case of tradable permits in Australia, **Box 12**).

2.3. Economic Instruments

As already mentioned, a shift to economic market-based instruments to combat water pollution is being experienced. The forces of economy point to the need for industry to internalise the true environmental and natural resource costs of its activities in its price structures.

Water charges are one of the most frequently used economic instruments, e.g. used in Philippines, Colombia and China (**Box 2,3,4**), and should be high enough to effectively induce changes in behaviour and foster preventive measures. It is recommended that such measures should be phased in gradually to take due account of the social and economic implications. An immediate response to high charges is not as easy to achieve in lower income countries as in industrialised ones. On the other hand, the effect of charges set at a fairly low level, as in some European countries in transition, is questionable. In this case, charges are low due to the present low economic status and the state of industry (38).

Concerning tradable permits, nutrient trading has been quite successful, for example in the Hawkesbury-Nepean river system in Australia (**Box 12**). Despite a significant number of examples on water pollution tradable permits, these remain restricted to very few countries such as Australia and the US, and each case is highly specific and not very amenable to broad generalisations (47). A significant precondition for the success of such schemes is the clarification of the ownership of the water resources, information intensity and proper monitoring, as well as political support.

Apart from the use of economic instruments that raise revenue partly for pollution control, the direct allocation of public funds is often necessary in order to carry out restoration measures (see case of the Great Lakes, of joint partnership and funding between US and Canada, **Box 5**). Governments can also contribute to water quality improvement through subsidy reforms, such as the case of removal of pesticide subsidies in Indonesia (**Box 8**).

To conclude, water pollution cannot be addressed by price and market-based schemes alone. Experience points to the combination of planning (e.g. EQOs), regulation (e.g. monitoring) and economic instruments (e.g. charges, tradable permits). The existence of direct regulations appear to be a necessary pre-condition for the successful implementation of economic instruments.

2.4. Co-operation

Several examples of co-operation among stakeholders are presented in Annex B such as bilateral

agreements (e.g. Great Lakes agreement between US and Canada, **Box 5**), river commissions (e.g. International Commission for the Protection of the Danube, **Box 6**), water pollution control through public information and participation (Indonesia **Box 7** and Canada, **Box 11**) and co-operation between private companies and local stakeholders (case of wetland nutrient retention funded by a private company in the US, **Box 9**).

The involvement of user and community-based organisations, which are expressions of civil society, is also increasingly recognised as a central principle in the protection of water resources. In this context, water user associations (WUAs) and farmer groups need to be properly trained and included in the debate. WUAs are common property management regimes that use economic instruments as part of their internal operation. They are often embedded in local customs and can be effective and efficient by promoting participation of users in the decision making process (47).

Lessons can also be learnt from the integration of different policy fields. For instance, failure to reduce diffuse pollution from agricultural sources, is often due to the fact that the formulation of agricultural policy does not take into account water resources protection (uncoordinated policymaking). Moreover, the agricultural sector is economically powerful, which makes it even more difficult to harmonise conflicting interests. Recently however, agriculture has begun to respond to environmental challenges and farmers in several rural areas are learning how to use less chemicals while boosting yields (biological pest control in Indonesia, **Box 8**). In the Chinese province Yunnan, since 1998, all farmers have eliminated their use of fungicides, while doubling rice yields. In Germany, water utilities now pay farmers to switch to organic operations because it costs less than removing farm chemicals from water supplies (29).

2.5. Ecological Services

„Win-win" cases concerning nature protection are important paradigms for developing countries, which are often concerned about halting development in the sake of environmental concerns.

Man-made wetlands that mimic the waste assimilation and self-purification functions of natural wetlands, are increasingly being used to clean water and retain pollutants in a sustainable way (**Box 9**). They are ideal where chemical treatment of diffuse source pollutants is very expensive. In the US, 300 man-made wetlands already treat polluted mine discharges and in Europe, they are increasingly used for the passive treatment of wastewater (7).

An accompanying measure to reduce water pollution is to enhance the self-purification capacity of the aquatic ecosystems. This is possible through restoring buffer zones, riparian forests, as well as river meandering.

3. ISSUES AND POLICY IMPLICATIONS

Although it seems that so far there have been limited success stories on pollution prevention world-wide, especially in the developing world, there is sufficient evidence to suggest that the problem of future management of water quality, though complex, is solvable. Surely it is not realistic to aim for zero water pollution, but a level of socio-economically acceptable pollution respecting the integrity of ecosystems can be reached. To this aim, several key areas, institutional, legal, technology transfer and governance issues, need to be re-examined.

3.1. Policy advocacy and governance

The need to formulate policies and apply instruments to encourage sustainable water use and consumption remains a major challenge both in industrialised and in developing countries. Policy responses to water pollution are, as a rule, based on a few principles: the polluter pays principle, the precautionary principle, the principle that pollution should be avoided at source and the prevention principle. Precautionary and preventive approaches instead of end-of-pipe solutions need to be promoted at all decision and policy levels and optimal combination of instruments (political, legal and economic) applied.

Realistic goals and priorities need to be set to halt and reverse water degradation according to appropriate indicators. Generalised statements about water quality improvements and unenforceable discharge regulations do not serve the purpose of water resources protection.

It is a priority to include water quality in national policies, where this has not been done yet. National working programmes with specific targets and timetables to combat water pollution should be designed. If national governments do not act and proceed to innovation in institutional arrangements, international actions such as the Vision of the 2000 Hague World Water Forum can achieve little.

Governments should align national policies with relevant international conventions and agreements on water pollution and protection of freshwater biodiversity. This will make sure that principles agreed at the international level are put effectively into practice.

Governments also have the power to encourage better service delivery provided by public and private sewerage operators by means of stricter control. They should ensure that sewage treatment is effective, and that sewerage does not stop at sewage collection as is often the case in developing countries.

Stricter action should be taken to combat corruption in the water sector, especially (but not only) in developing countries. Corruption leads to ineffective implementation of water protection policies and undermines the efficiency of pollution prevention policies. In general, policy formulation and decision-making for water pollution control should be transparent for the public. The implementation of policies, plans and strategies to protect water resources should be participatory, allowing for consultation between government, industry and the public.

At the national and regional level, water pollution prevention policies should be integrated into non-water policies that have implications on water quality such as agriculture and land use management, trade, industry, energy and urban development. It is increasingly recognised that integrated water protection planning is suitable for the reduction of many forms of water pollution. Allocation of actual responsibilities on pollution prevention to regional agencies as well as ownership of water resources by local elected bodies can contribute to effective and responsible management of water quality. To avoid a degradation of water resources due to short term greed taking advantage of local decision-making, local level empowerment must be embedded in centrally-set minimum requirements. It should thereby be subject to monitoring and reporting, as well as peer review of the implementation for water pollution control policies. Interregional co-operations should be built to deal with water pollution problems that exist at the local level but can not be solved independently from other regions, e.g. agricultural diffuse pollution.

3.2. Financial resources

An effective administrative structuring and good water governance can be more effective once investment tools and the participation of the private sector are developed in order to mobilise financial resources**.** Governments, donors and NGOs, local and international private sector and water user associations can work together to increase and improve the utilisation of funds. Investment in water management and services should increase significantly, especially in developing countries, and be more effective and efficient. It has been noted that although the government is the largest investor, there is increasingly a shift to the corporate sector (66).

Governments should ensure and increase the powers and budgets for environmental enforcement, given the fact that non-compliance from significant emitters is still very commonplace. The effectiveness and power of the "polluter pays" principle should not be underestimated. Industry and private organisations should be held responsible and made to pay for point source pollution. Higher fines and penalties for polluting corporations bring revenue that can be used in the fight against water pollution. Such instruments of environmental enforcement combined with true implementation of laws governing waste management practices can force the industry to find innovative methods for non-contaminating waste, treatment and recycling wastewater.

Municipalities and governments can raise resources for pollution prevention through (earmarked) charges. The charges can serve as incentives to adapt behaviour and raise revenue that can be

put to use in water management.

To combat water pollution caused by agriculture, subsidies can be attached to the fulfilment of environmental or water quality requirements. Subsidies that indirectly lead to water pollution, such as subsidies for agrochemicals, have to be removed.

In the majority of cases, it will be impossible to allocate the costs for water purification to the farmers according to the polluter pays principle, in particular in cases where water pollution arises from diffuse pollution. However farmers should follow the precautionary principle, the prevention principle and the principle that pollution should be avoided at source and bear the responsibility (also financially) for quality restoration in case of failure. The latter requires respective national legislation and policies.

3.3. Legal reform

Water pollution should be made a punishable offence – with a de minimis rule to deal with minor or common use of water and the resulting pollution. On the basis of that rule, competent authorities may then grant (temporary) discharge permits and impose conditions on any pollution (maximum concentration, maximum loads, reference to environmental quality objectives, seasonal variations, monitoring duties, data reporting, responses to emergencies, etc).

The setting of standards of water quality, both for effluents and for the receiving waters, on an appropriate legal basis should become a priority, where no such standards exist. A comprehensive and reliable data analysis should be a requirement by national law. Such a collection of data and national reporting serves as a basis for formulating priorities and future policies on water pollution prevention.

It is necessary to set a time frame for the phase out of hazardous or persistent substances. To this end, legally-based substance bans, restrictions on their trade and use, including substitution policies and technology-derived emission standards are particularly effective instruments as they stimulate technological change. Of primary importance, for instance, is the ratification and implementation of the Convention for Implementing International Action on certain Persistent Organic Pollutants.

3.4. Integrated water management

A catchment management approach should be developed, wherever possible, since it addresses water pollution control. This approach combined with participatory networks of the local population sets out an alternative to conventional top-down and sectoral approaches that can fail to produce desired results and often lead to further water resources degradation. To this effect, land and water management should be better integrated, and greater control should be exercised over land clearing activities, which impact water quality through soil erosion.

Integrated water resource management can only be successful once legal and institutional barriers between different sectors are removed. Government branches and authorities responsible for the water policy sector, including water pollution control, should be re-organised and better co-ordinated in order to achieve administrative efficiency and effectiveness.

In the context of integrated water management, the option for water utilities to manage water supply and sewage together should be explored. This would allow them to have control (and responsibility) over water quality throughout the complete water cycle, thus providing an incentive for improved and co-ordinated action towards water pollution prevention.

3.5. Participation and co-operation

Of equal importance for the success of working programmes is the participation of stakeholders, including local authorities and community representatives, disadvantaged groups, such as in many

cases women and NGOs, in decision-making processes and in the governance structures of water user associations. Institutional and regulatory measures should be considered to ensure such participation. Appropriate means of public participation, such as the “water parliaments” in France, or the water user associations in North Rhine-Westphalia in Germany, can be designed for other regions according to their cultural and societal structures.

Given that freshwater pollution affects all, co-operation between different kinds of water users and the building of new partnerships between various stakeholders are considered vital for pollution prevention strategies. Partnerships can involve governments, local communities, NGOs, donors, international organisations, municipal authorities and private operators. Regional co-operations, such as river basin management committees and river commissions, which already function successfully, can serve as models for other regions facing similar problems.

3.6. Technology

Technology development and technology transfer schemes from industrialised countries and private industrial enterprises to developing countries should include innovative instruments, pollution control plans and research contributing to better infrastructure and surveillance facilities. For the urban poor, new techniques for cost-effective, sustainable and easy-to-handle sanitation systems are particularly helpful. Water-wise technologies, such as closed loop approaches to complement end-of-pipe wastewater treatment can be appropriate solutions for industries operating in environments affected by water scarcity and quality degradation.

In water pollution technology transfer, it should be kept in mind that culturally and locally adapted technologies for sewage treatment are most effective. Each applied technology must be specifically adapted to the people's socio-cultural background. Otherwise, it will not be accepted.

It is a priority to address the issue of diffuse water pollution and sanitation in slums of expanding urban areas in developing regions. Non-point urban water pollution is a rising challenge, which can be addressed with proper town planning accompanied by simple, low-cost engineering structures for wastewater treatment. The latter is an immediate response to the social problem of untreated wastewater that asks for an urgent solution. In the long term, technological solutions have to be embodied in strategies of population control and sustainable urbanisation, which can significantly contribute to curbing urban wastewater emissions and preventing increasing pollution.

Agencies, public or private, who are given responsibility for pollution control in urban areas of developing regions, should engage in long-term planning. This should involve providing at least primary treatment of wastewater in the beginning, and allowing for expansion of the treatment infrastructure to include higher-level treatment in the future.

3.7. Information and capacity building

To improve decision-making, it is necessary to improve the flow of information towards all stakeholders (the public’s right to know). Often lack of public awareness on the importance of water pollution prevention and low participation in improvement efforts contributes to a deterioration of the pollution problem (40).

Communication campaigns to ensure long-term effectiveness of pollution reduction measures can prove very successful. International organisations and governments should establish mechanisms for data collection and information gathering.

The local communities can be empowered through knowledge and should be involved in the design and implementation of urban and rural water programs. Environmental education of farmers, industries and manufacturers as well as public discourse and access to information should be enhanced. Especially women in developing regions need access to information and training on how to improve water pollution prevention at the community and household level, on sanitary and hygienic practices, and proper waste disposal and management.

Institutional capacity building and efficiency enhancement in the local government, central administration and civil society needs to be promoted and their roles and responsibilities clearly

and officially defined. There has been an increasing awareness of the need to strengthen technical and managerial capacity at all levels of government and local community level (66). At the local level, capacity building enables the community to make decisions and disseminate them to the appropriate authorities (40), thus influencing political processes.

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ANNEX

A) Current Situation

Part I: Regional Overview of Water Pollution (details and data)

European Union (EU)

Eutrophication is one of the main water pollution problems due to the application of large amounts of fertilisers to a relatively small total land area. Nevertheless, fertiliser application has decreased significantly in recent years (7). This has reduced phosphorus levels notably but nitrate levels still remain high (30). Organic pollution still remains a problem, although there have been large reductions in organic matter during the last 20 years. In **Western Europe**, the percentage of heavily polluted rivers has fallen from 24% in the late 1970s to 6% in the 1990s (26) due to improvement in wastewater treatment, emission controls and reduced use of phosphorus in detergents (16). The trends are not reflected in the **southern Member States**, where about 50% of the population is not yet connected to sewage treatment operations (20). Acidification also remains a problem in northern and eastern Europe. The contamination of groundwater by nitrate and pesticides is also expected to deteriorate (9). Concentrations of POPs are especially elevated in the vicinity of the larger European cities and industrialised areas (30).

North America

Agrochemical run-off is the main source of water pollution in the agricultural regions and has contaminated groundwater and other water bodies in many areas. Over the past decade, however, there has been an improvement in the drinking water quality. In the **US**, significant achievements in reducing industrial pollutants have been made through the Federal Water Pollution Control Act of 1956 and the Clean Water Act in 1977. Nevertheless, new pollutants have been introduced into the water supplies, as the scope of economic activity has grown, and lately cases of contamination by industrial chemicals are being more often detected (16).

Japan

Concentrations of toxic substances, such as cadmium and cyanide, have decreased through the strengthening of environmental policies. Problems still exist with organic pollution and lake eutrophication and new problems arise from endocrine-disrupting chemicals, such as dioxin (16) and microbes. Residential sewage, pesticide runoff, industrial discharges and groundwater contamination by toxics and nitrates also need to be tackled (5).

Australia and New Zealand

In **Australia**, nutrients, particularly phosphorus, remain unacceptably high. Sedimentation continues to foul rivers in both Australia and New Zealand but In the latter the removal of sheep from steep pastures is now leading to improvement. Sewage pollution has also been reduced due to the sharply increased number of sewage treatment plants (16).

Eastern Europe & Russian Federation

In the Czech Republic and Slovakia, 57% of the drinking water in 1990 failed to meet established water quality criteria (30), while in Poland, 70% of all water may be undrinkable (43). In the Russian Federation, 1400 areas with polluted groundwater have been identified with industry, agriculture and municipal landfills being the main polluters. High levels of PCBs have been detected in Russian rivers and in some cases, the level of POPs draining into the Arctic may be higher than those found in urban America or Western Europe (16).

Latin America

Domestic sewage volumes are far higher than industrial ones, since the urbanisation level of the region is very high, with nearly 75% of the population living in megacities (16).Currently only 2% of urban sewage is treated, while untreated effluents cause major problems with water supply and proliferation of pathogenic diseases (9). The mining industry, with gold being the most mined mineral, is also a major polluter and its activities lead to high mercury emission (16). Under present trends, mining will continue to be a major source of water pollution in the region (9).

Agriculture still remains the main polluter in **Brazil, Colombia and Ecuador** which are the continent's main users of pesticides. Nitrate pollution is expected to become a serious problem in **Brazil**, under present trends (3).

Asia and the Pacific

In the region of **Asia and the Pacific**, sediment loads, which are a major source of pollution in Asian rivers, are four times the world average and 20 times the OECD levels (16). Hazardous and toxic waste are also threatening. Asia's surface water, characteristically, contains 20 times more lead than surface water in OECD countries (16). Asia has, furthermore, faced the most rapid growth in eutrophication due to fertilisers, in concrete a 15-fold increase between 1961 and 1991 (7). Oil production is also expected to cause major hydrocarbon pollution of freshwater and marine ecosystems (9). Finally, pathogenic agents still remain a major problem and Asian rivers contain 3 times as many bacteria from human waste as the world average (16). Urbanisation connected to large quantities of untreated sewage and industrial waste threats to cause severe water pollution problems (9).

Water pollution trends have particularly worsened in **China** in recent years, with the pollution adjacent to industrially developed cities being particularly severe. Although the amount of industrial wastewater has levelled off since the early 1990s, inadequately treated municipal discharges have increased rapidly. Agricultural pollution also poses a threat since China is the world's largest consumer of synthetic nitrogen fertilisers. (20).

Southeast Asia

Bangladesh and adjacent parts of **India** suffer from arsenic contamination of groundwater, although natural geological reasons are the primary cause. In **Bangladesh**, arsenic poisoning of groundwater has affected more than 50% of the total area of the country, threatening with a public health disaster, if it gets into the food chain (5). Excessive levels of nitrates lead to the eutrophication problems of the region (16). Nitrate pollution may become a serious problem in India (3), considering that fertiliser consumption is projected to double by 2020 (20).

West Asia

Deep concern over health impacts because of water pollution have been expressed in the **Mashriq** sub-region (Iraq, Jordan, Lebanon, Syrian Arab Rep., West Bank and Gaza), where raw and partially treated wastewater is discharged into water courses (16). In the **West Bank** and **Gaza**, faecal contamination of groundwater is widespread, pesticide levels are believed to be high, while nitrate concentration in some domestic wells may reach four times the WHO limit. In some central areas, groundwater is no longer potable and 5 million m^3 of drinking water are transported into the area every year (16).

Part II: Impacts of water pollution

Impact on ecosystems

Eutrophication decreases the available oxygen dissolved in water and releases ammonium which is poisonous to fish (27). It also often results in explosive growth of algae which causes disruptive changes to the total biological equilibrium, both in inland and coastal waters (52). In the **US**, eutrophication accounts for 70% of the nation's ecologically impaired river reaches and streams and 49% of affected lakes (8). In **Europe**, lakes and reservoirs have also been affected by eutrophication, but there has been a general improvement in the quality of lakes during recent decades (30).

There is also increasing concern about the effects of exposure of aquatic life to *pesticides* and other toxic compounds, since these can have a negative impact on fish growth, development, behaviour and reproduction (41). In the **US**, a large percentage of the freshwater fauna is at risk of extinction, imperilled or partly killed by agricultural chemicals (8).

Acid rain has caused great damage to ecosystems mainly in **North America** and **Europe** (3). By the 1990s, acid rain had caused a 40% decline in fish species in lakes in **Canada** (28). However it increasingly affects developing countries as well, and in **China**, for instance, acidification levels have recently approached those found in the United States (39).

Economic impacts of water pollution (Examples from selected regions)

- Recently, the city of Shanghai in **China** had to invest 300 million US$ to move its municipal water intake many kilometres further from the city as the nearby river source had become too polluted by industrial waste (58).

Evidence on escalating costs of water remediation comes from Lima, in **Peru**, where upstream pollution has increased water treatment costs by about 30% (19).

Regarding the purification of contaminated groundwater, its initial cleanup at 300,000 sites in the **US** could cost 1 trillion US$ over the next 30 years (29).

- The annual impact of degradation in irrigated areas, mainly through salinisation, is a loss of around 1.5Mha of irrigated land in the world's dry areas, and approximately 1 billion US$ from reduced productivity globally (53).

- In a number of regions in **Asia** and the **Middle-East**, water supply and prices are emerging as one of the major constraints in growth of industries (50). In China, the problem of water scarcity and water pollution already has a costly toll on productivity, while water shortage in cities causes a loss of an estimated 11.2 billion US$ in industrial output each year (20).

- In the river **Danube,** nutrient concentrations have increased six-fold and have harmed the region's fisheries over the last 25 years (8). This has consequently affected the source of income of the region's inhabitants.

B) Success Stories and Lessons Learned

BOX 1-River Thames, UK

Industrialised country, environmental quality objectives

The river Thames, in England, was polluted for centuries, and even more intensively in the 19th century, due to the industrial revolution. Gradual improvement in water quality was achieved through major investments in wastewater treatment and cleaner production in order to meet the set environmental quality objectives. Even the salmon returned to the river, and the case of the Thames "clean-up" is often quoted as an example of what can be achieved with consistent effort over a long period by setting water quality objectives and clear goals (40).

BOX 2-Laguna Lake, Philippines

Developing country, industrial point source pollution, charges

In the Philippines, authorities adopted in 1997 environmental user fees to combat industrial pollution of the Laguna Lake. The fees consisted of a fixed charge determined by discharge volume and a two-tier assessment for emissions, which consisted of one charge per unit of emissions that meet the permissible standard, and a higher charge per unit of emissions that exceed the standard. After two years of implementation, notable reduction of the organic input to the lake was achieved (24). The scheme is implemented by the Laguna Lake Development Authority (LLDA) which is also responsible for a river rehabilitation scheme on six priority major tributaries. LLDA has recruited industries along the river to work together with local governments, local fishing organisations and environmental groups to implement the rehabilitation plan for the river. Although the initiative has been positive, still much has to be done.

BOX 3-Eastern Antioquia, Colombia

Developing country, point sources, escalating charges, incentives, governance-decentralisation

In Colombia, the majority of industrial and agricultural waste goes untreated and 75% of diseases are related to poor water quality. In 1995, having reached a critical level of pollutants in the nation's water courses, environmental authorities in the region of Eastern Antioquia took drastic action imposing fines and closing factories. Unfortunately, the scheme failed as industries started to look for "loopholes" to avoid penalties.

In 1997, new incentive-based regulations were enacted which provided businesses and municipalities with new flexibility to meet water-pollution standards. Indeed, the scheme proved successful and led to a reduction in organic waste by 36% and suspended solids by 52% by the end of 1999. Apparently, the scheme of escalating charges starting low and rising with time provided the right incentives for polluters to reduce their emissions in their own time and using the preferred technology. Authorities raise charges every six months if discharge targets are not met and this continues until local targets are met. Pollution charges were moreover paid to local authorities, which now had an incentive to measure pollution and penalty violations. A reduction of 15% in industrial and of 25% in agricultural waste has been accomplished in the 3 years of escalating charges implementation. However, the process is not yet very successful in other Colombian regions due to political obstacles and pollution there still remains high.

In general terms, the scheme has proven successful and it has emerged as a model for developing world communities with rising pollution problems. Brazil and Chile are also exploring market-based instruments against pollution, while Malaysia, the Philippines and China have already implemented economic instruments to improve water quality (21).

BOX 4-China

Lower income rapidly industrialising country, industrial pollution, incentives, charges and subsidies, levy, community pressure

The amount of industrial wastewater has levelled off since the early 1990s (20). In China, industries operate under a market-based pollution control system, which combines emissions charges and abatement subsidies. This combination has given firms incentive to invest in wastewater treatment facilities. A pollution levy, although low, has contributed to significantly improved investments in abatement (22).[6] Relevant research in China has also showed that community pressure may be as strong an incentive for industrial firms to control pollution as the pollution levy is.

BOX 5 -Great Lakes, US-Canada

Industrialised countries, binding legal framework, planning, partnership, investment

The partial recovery of the Great Lakes from water pollution was a result of the joint action between US and Canada, in the framework of the Great Lakes Water Quality Agreement in 1972. This achieved to strongly curb the dumping of phosphorus and municipal sewage into the lakes (8). In the same area, 10 million US$ were spent between 1970 and 1980 to quantify the relative impacts of point versus non-point sources. The project proved very successful and specific policies were adopted for nutrient control in each lake basin in Canada and the US that reflected the relative contributions from each type of source (52). The US and Canada have basically an effective institutional system for effective ecosystem approach by setting up the International Joint Commission. Co-operation of the governments has in essence changed behaviour towards the ecosystem. Significant resources were devoted to studying the ecosystem and carrying out clean-up programmes and restoration measures. Collaboration with industries has been effective and broad participation (provinces, environmental and citizen organisations) was ensured. Despite serious disagreements at times, the two countries have continued to participate in the Joint Commission.

BOX 6-Danube River, Europe

Industrialised countries and countries in transition, partnership, bottom-up approach, governance, stakeholder participation, awareness raising

The phosphorus pollution of the Danube has decreased since 1990 as a result of the decline in industrial production (collapse of Eastern Block and decline of industrial activity) and fertiliser use in some of the river-basin countries (16). The International Commission for the Protection of the Danube River has developed the Danube Pollution Reduction Programme (DPRP) within a Transboundary Basin Analysis. This involves stakeholders in 11 countries and aims to prepare for funding pollution prevention and reduction activities required to restore the Danube River Basin and to protect the Black Sea environment. The process is intended to enhance the NGO participation on the national and regional level, to assist public awareness raising, reinforce co-operation with government agencies and create a general sense of responsibility and engagement of all stakeholders in sustainable management of international waters. Until now, the project has been successful in achieving among others the development of national reviews, the organisation of national planning workshops, the development of transboundary analysis, and of a strategic action plan for the whole basin (49). The project adopted a bottom-up approach and activities initially focused on the national level, which then consisted the basis for regional activities.

[6] *The study however focused on top polluters, and may not be valid for other sources of industrial pollution.*

BOX 7-Indonesia

Developing country with growing industry, industrial pollution, public disclosure, information

Indonesia's Program for Pollution Control, Evaluation and Rating (PROPER) launched in 1995 was a response to the risk of water pollution damage due to weak formal regulatory enforcement. Within this scheme, each factory is assigned a colour rating by the government according to its environmental performance. During its first two years in operation, PROPER proved quite effective in moving poor performers toward compliance (20). Armed with PROPER-type performance ratings, citizens are in a much stronger position to negotiate pollution control agreements with neighbouring factories. The PROPER system adds critical information to this picture and certifies the claims of local communities, which can use PROPER's ratings to engage the most serious polluters (24). Therefore, social incentives can also prove efficient. An informed public can achieve much through informal pressures.

BOX 8-Indonesia

Developing country, capacity building, governance, pesticide subsidy reform

In Indonesia in 1986, a presidential decree banned 57 insecticides for use on rice and called for massive efforts to train government field staff and farmers in methods of biological pest control. In the meantime, there followed complete removal of pesticide subsidies within two years and a national integrated pest management programme was implemented. Thus, a massive reduction in pesticides was attempted to respond to crop damage initially, and in the same time protect water courses from pollution. The project is accompanied with supportive training programmes and has trained 600,000 farmers, while it is strengthened and disseminated through community mechanisms.

BOX 9-Ladish Malting, USA

Industrialised country, mobilising financial resources, partnership, wetland nutrient retention

To combat water pollution caused by its processes, Ladish Malting, a malt processing company in the US, created a wetland in 1992 in co-operation with local farmers. The company's waste water flows through the artificial wetland and ultimately provides irrigation water for nearby farm land. In the same time, the wetland, which was not very costly to set up, benefits wildlife by creating permanent habitat. The project, therefore, has been a win-win situation for nature, for the company by reducing its wastewater treatment costs, and for the local farmers who obtained low cost irrigation water. This case shows that natural or man-made wetlands can effectively remove pollutants inexpensively, when waste water contains only biological material (33).

Box 10-Israel

Industrialised country, governance – decentralisation (river authority), awareness raising, capacity building

In Israel pollution problems are not yet top of national priorities. In the case of the River Kishon (54), oil refineries and petro-chemical industries were established, under the British Mandate, near the river to discharge effluents "easily". Over the last five years, however, there has been action to restore the river by the locally established Kishon River Authority. Progress has been slow but consistent and improvement is being achieved through monitoring, research, data collection regarding industrial emissions and the rise of environmental awareness.

Box 11 - Canada

Industrialised country, industrial pollution, governance, instrument mix (public disclosure and regulation)

In British Columbia, in Canada, there is a pollution control program in place combining traditional enforcement (inspections, fines and penalties) and information strategies (public disclosure). Since July 1990, the Ministry of Environment, Lands and Parks of British Columbia publishes twice a year a list of firms that either do not comply with the existing regulation or whose environmental performance is of concern to the Ministry. In the same time, the Ministry continues to undertake legal action for those violating the regulation (67). A study on the results of the program suggested that the public disclosure strategy adopted has a larger impact on both emission levels and compliance status than fines and penalties (67). However, the adoption of stricter standards and higher penalties also had a very significant impact on emission levels.

In this case, the lesson learnt is that information strategies are useful but can not necessarily replace traditional enforcement practices in water pollution control. The two approaches are better used as complementary policy instruments in order to achieve compliance with standards. The penalty system has to be significant and credible, standards clear and strong, while public disclosure of industry performance creates additional and strong incentives for water pollution control.

Box 12 – Australia

Industrialised country, instrument mix (tradable permits and regulation)

In the Hawkesbury-Nepean river system in Australia, success in nutrient pollution control was achieved within the conceptual framework of a "bubble licence" regime over point sources and allocation of tradable permits. Instead of concentrations, the focus is on loads of pollutants entering a river system, similar to environmental quality objectives. Thus, the regulator controls the total load generated from multiple sources within the "bubble", instead of controlling emissions from individual sources. In the meantime, the operator has the flexibility to search for cost-effective pollution abatement solutions, while ensuring the overall discharge targets are met. Trade of nutrient pollution permits was, nevertheless, effective within strong and pre-existing regulatory regimes that include sanctions on individuals for overall failure in pollution abatement (47).