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Water Quality in Developing Countries, South Asia, South Africa, Water Quality Management and Activities that Cause Water Pollution

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Abstract. Water is the most abundant chemical in the human body and plays a central role in the regulation of nutrient transport, toxic waste removal, thermal regulation, digestion, and organ functioning. About 55-65% of the human body weight comes from water. To maintain optimal health, the Institute of Medicine advises that men consume roughly 3.7 liters (about 16 cups) of total water a day and women consume 2.7 liters (about 12 cups) of total water a day. So water quality should be grow faster day by day in order to maintain people 's health. Protecting water quality is a top environmental priority as we approach the twenty-first century. There are many water quality problems in both developing and developed countries. Of all the environmental concerns that developing countries face, the lack of adequate water of good quality is probably the most serious. The sustainable management of water quality has policy, technical, institutional and financial components. In many developing countries restricted funding is usually combined with fragile or unstable institutions and limited technical capabilities to deal with an expanding range of water quality problems. At the technical level, there has been great progress in western nations in developing more cost-effective monitoring, analytical protocols, and assessment methods. This flows not only from better scientific knowledge, but also from recognition that conventional monitoring programs are inefficient, expensive, and often not very useful. Regrettably, financial institutions and ODA programs tend to reinforce conventional approaches in developing countries with the result that these countries have little opportunity to develop a new, more appropriate and more sustainable data paradigm. In lesser developed countries where public health is the major concern, the traditional model of a centralized monitoring program often does not work, suggesting that a new model of decentralized community-based monitoring would be more effective. All waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. In addition, drainage waters from irrigated lands and effluent from city sewage and industrial waste water can impact water quality.

Keywords: global water crisis, water quality management **,** COD, WHO, National Environment Program , Persistent Organic Pollutants

1. Introduction

Although the "global water crisis" tends to be viewed as a water quantity problem, water quality is increasingly being acknowledged as a central factor in the water crisis. The fact that some five million persons, mainly children and infants, die annually from water-borne diseases, was not enough to mobilize international action about water quality. There is no doubting the importance that national governments and international financing agencies place on addressing the water problem.

The water quality situation in developing countries is highly variable reflecting social, economic and physical factors as well as state of development. And while not all countries are facing a crisis of water shortage, all have to a greater or lesser extent serious problems associated with degraded water quality. In

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some countries these are mainly associated with rivers, in others it is groundwater, and in yet others it is large lakes; in many countries it is all three. Because the range of polluting activities is highly variable from one country to another, and the nature of environmental and socio-economic impacts is equally variable, there is no "one-size-fits-all" solution.

Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also affected by floods and droughts and can also arise from lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resources.

This paper explore the key aspects of water quality management that should enter into national water programs irrespective of the type of pollution or the type of water body concerned ,the current status of water access for households in developing countries, Agricultural activities that cause NPS pollution and water quality south Asia and Africa.

These components reflect important technical, institutional, legal, financial and business issues which should be included in national water policies.

2. Water Quality Management

Water quality is changed and affected by both natural processes and human activities. Generally natural water quality varies from place to place, depending on seasonal changes, climatic changes and with the types of soils, rocks and surfaces through which it moves. A variety of human activities e.g. agricultural activities, urban and industrial development, mining and recreation, potentially significantly alter the quality of natural waters, and changes the water use potential. The key to sustainable water resources is, therefore to ensure that the quality of water resources are suitable for their intended uses, while at the same allowing them to be used and developed to a certain extent. Effective management is the tool through which this is achieved. Water quality management, therefore involves the maintenance of the fitness for use of water resources on a sustained basis, by achieving a balance between socio-economic development and environmental protection. From a regulatory point of view the "business" of water quality management entails the ongoing process of planning, development, implementation and administration of water quality management policy, the authorization of water uses that may have, or may potentially have, an impact on water quality, as well as the monitoring and auditing of the aforementioned.

2.1. The Policy Regime in Water Quality management

Apart from effluent regulations and, sometimes, national water quality guidelines, a common observation is that few developing countries include water quality within a meaningful national water policy context. Whereas water supply is seen as a national issue, pollution is mainly felt at, and dealt with, at the local level. National governments, with few exceptions, have little information on the relative importance of various types of pollution (agriculture, municipal, industrial, animal husbandry, aquaculture, etc.) and therefore have no notion of which is of greatest economic or public health significance. Consequently, it is difficult to develop a strategic water quality management plan or to efficiently focus domestic and donor funds on priority issues.

A national water policy should include:

1. A policy framework that provides broad strategic and political directions for future water quality management.

2. A strategic action plan for water quality management based on priorities that reflect an understanding of economic and social costs of impaired water.

This plan will include:

- A mechanism for identifying national priorities for water quality management that will guide domestic and donor investment.

- A consideration of options for financial sustainability including donor support, public-private sector partnerships, regional self-support initiatives, etc..

- A plan for developing a focused and cost-effective data program for water quality and related uses, as a basis for economic and social planning.

- Establish specific mechanisms for providing drinking water monitoring capabilities, at the community level if necessary.

- Establish (national) data standards: These must realistically reflect national needs and capabilities. Nevertheless, the objective is to ensure reliable data from those organizations that produce information for national water management purposes and at the community level for drinking water monitoring.

- A regulatory framework that includes a combination of appropriate water quality objectives (appropriate to that country and not necessarily based on "western" standards) and effluent controls. This includes both surface and groundwater.

- A process for tasking specific agencies with implementation so that accountability is firmly established and inter-agency competition is eliminated.

- A methodology for public input into goals and priorities.

2.2. The Principles of Data Programs

A common observation amongst water quality professionals is that many water quality programs, especially in developing countries, collect the wrong parameters, from the wrong places, using the wrong substrates and at inappropriate sampling frequencies, and produce data that are often quite unreliable; the data are not assessed or evaluated, and are not sufficiently connected to realistic and meaningful program, legal or management objectives. This is not the fault of developing countries; more often it results from inappropriate technology transfer and an assumption by recipients and donors that the data paradigm developed by western countries is appropriate in developing countries (Ongley 1993).

Water quality monitoring, as practiced in most developed countries, is based on the premise that with enough data, a well designed program can answer most types of water quality management issues. This has been referred to as a data-rich or data-driven approach in which the objective is primarily to gather high quality data. This has recently been challenged by the United States government which found that, despite years of expensive data programs, one cannot tell whether the nation's waters are getting better or worse. The consequence has been the realization that these mainly chemistry-focused programs are expensive, focus on data production rather than on data use, collect more data than is necessary, often do not reflect the types of data that managers need, and can be replaced by cheaper and more effective methods. The outcome in Canada and the United States has been a substantial shrinkage of conventional water quality data programs and an expansion of alternative approaches. Regrettably, this expensive and often ineffective chemistry-focused approach is the one now being adopted by developing countries and is being recommended by international and multilateral organizations. Most developing countries are "data-poor" environments as well as being challenged by economic restrictions. This, together with lack of sufficient technical and institutional capacity and often a poor scientific knowledge base, suggests that the conventional "western" approach to water quality monitoring and management is not well suited to many if not most developing countries. It is, therefore, timely to promote a new water quality paradigm that is more suitable, affordable, and sustainable in developing countries.

The need for a new paradigm has been recognized in several parts of the developing world during the "Vision" exercise carried out by the Global Water Partnership and the World Water Council over the past years. Unfortunately, this situation tends not to be recognized by institutions such as the World Bank, UNDP and others, and in many ODA programs. As examples of this situation, in a recent program of the World Bank in one large developing country, "modernization" of monitoring was largely linked to procurement of advanced equipment and laboratory infrastructure which local experts say is unlikely to have much impact on the types of data that are really needed for decision-making. The decisions appear to have been largely driven by in-country technical staff for whom advanced facilities were out of reach and who had no responsibility for the larger issues of program efficiency or relevancy. In contrast, a World Bank program in Mexico responded to the Mexican government's desire to fundamentally restructure the national water program with the result that water quality data program and related legal and institutional change, was measurably more efficient and effective and was able to effect a savings of 66% of the amount that the national agency originally requested to extend its existing program (Ongley and Barrios, 1997)

The solution to this situation is a process now referred to as “modernization” of water quality programs (Ongley, 1997, 1998). This addresses policy, institutional, legal and technical components of water quality programs. It also takes advantages of a large number of improvements in monitoring and assessment technologies that reduce costs, increase efficiencies, improve accuracy, and focus programs on meaningful data objectives. Because multilateral agencies have not, generally, recognized the seriousness of the data problem, even for their own lending programs, there remains a lack of written practical guidelines for carrying out the modernization process.

2.3. Water Quality Remediation: Science, Knowledge and Capacity

It is an unfortunate fact that the rate of increase in types and complexity of water quality problems (indeed, of all environmental problems) will exceed the rate of capacity development for a long time to come. When looking at loan profiles of major lending institutions, it is clear that a major developing trend is the remediation of degraded water quality. This tends to fall into two types of projects -- (i) remediation of highly eutrophic lakes (e.g. many such projects in China), and (ii) remediation of contaminated river systems.

Remediation brings into focus the stark reality of profound deficiencies in national scientific competencies and, in some cases, similar deficiencies in foreign "experts". Few developing countries have the technical knowledge or experience to make good judgements about appropriate interventions for remediation of large lakes and complex river systems. This includes problem identification, setting of rational and defensible program objectives, and implementation methods.

Two example will describe this point:

(i) Large and typically shallow lakes in Asia tend to be highly eutrophic with extreme algae problems causing both environmental and economic consequences. A control plan requires a knowledge of point and non-point source loads, and a reliable estimate of the "internal" load of phosphorus that is contained in lake bottom sediments and which may be larger than all the other loads combined.

Nevertheless, non-point and internal loads are rarely known (a result of lack of data and lack of knowledge) with the consequence that many lake restoration projects have unrealistic and often unachievable objectives and, in some cases, may produce no change whatsoever in lake quality. In one large lake program now being developed in a major Asian country, the official objectives are, in fact, quite the opposite of what will actually happen, as the lake will inevitably deteriorate for some considerable time before any improvement can be expected.

Dredging of lake bottom sediments is the common response to extreme eutrophication of lakes. The decision to dredge is usually made by in-country program managers who have no knowledge of alternatives and lack the science to determine the likely outcome. dredging is well known to be largely ineffective, hugely expensive, and often makes the problem worse, not better. Lake Dianchi, a large lake in southwestern China, is just one example where a major dredging program has made the situation worse for reasons that could have been easily anticipated.

(ii) Remediation of contaminated rivers presents another set of problems for which there is insufficient in-country scientific capability to properly scope the issues, define objectives, identify implementation options, and confidently predict expectable results. In many advanced developing countries, for example, the principal regulatory parameter is COD (chemical oxygen demand), yet COD is only an indicator parameter that measures the aggregate effect of a large variety of chemicals, including toxic and/or carcinogenic substances, that have different sources, different environmental pathways, different environmental and human health effects, and different probabilities of being eliminated by alternative remediation options. In-country agencies rarely have the technical capacity to make the analyses that are required to properly scope the various options for remedial interventions.

2.3.1. Some Solutions for Sustainable Capacity Development

a. Lending institutions need to set measurable performance criteria for capacity development, especially in those projects that require a high degree of foreign expertise.

b. developing countries do not want to be hostage to western technologies. However, we must distinguish between technologies and know-how that are the intellectual property of western companies, and domain knowledge (that which is known about some area of science or technology and is in the public domain). The challenge is how to bring domain knowledge into the hands of local decision-makers. One common approach is technology transfer that usually include workshops, short training, and access via computer-related technologies (the Internet, etc.) but this works only for simple technologies, It does not work well for complex technologies, such as lake and river remediation techniques that require both an extensive background in aquatic science and implementation expertise.

c. Conventional practice, combined with a lack of knowledge of modern remediation science, is a profound barrier to the use of cheaper and more effective approaches. for example dredging is well known to be ineffective and expensive for remediation of eutrophic lakes. Modern science tells us that remediation of large shallow lakes is not possible over short periods of time. There are non-conventional and economic technologies that can be successfully applied to deal with a variety of specific problems such as odour, aquatic weeds, etc..

3. Environmental Health Risks

The environmental risk factors are: unsafe water, sanitation and hygiene; urban air pollution; indoor smoke from solid fuels; lead exposure; and climate change. Table 1 shows how the environmental risk factors are assessed. Among these seven factors, unsafe water, sanitation and hygiene is the leading cause of mortality and morbidity in high-mortality developing countries; and is among the top five of all risk factors (environmental and non-environmental) in the same countries. Unsafe water, lack of sanitation facilities and poor hygiene practices may cause of diarrheal disease and other illnesses related to the risk factor of interest (e.g., Schistosomiasis , Ascariasis , Trachoma, Trichuriasis and Hookworm disease).

Table 1: Environmental risk factors to health

Risk factor	Theoretical minimum exposure	Measured adverse outcomes of exposure
Unsafe water, sanitation and hygiene	Absence of transmission of diarrheal disease through water, sanitation and hygiene practices	Diarrhea and other illnesses related to the risk factor
Urban air pollution	7.5 µg/m^3 for $PM_{2.5}$	Cardiovascular mortality, respiratory mortality, lung cancer, mortality from acute respiratory infections in children
Indoor smoke from solid fuels	No solid fuel use	Acute respiratory infections in children, chronic obstructive pulmonary disease, lung cancer
Lead exposure	0.016 µg/dl blood lead levels	Cardiovascular disease, mild mental retardation

Source: Adopted from WHO (2002).

4. Pesticides and Water Quality

We must acknowledge the importance of pesticides in controlling pests in our homes, restaurants, hospitals, parks, ornamental plantings, golf courses, etc. But at the same time we must be aware that pesticide applications can affect water quality. Human and environmental health may be threatened when excessive concentrations of pesticides enter surface or ground water.

State and federal agencies are responsible for implementing and managing.

- Legislative statutes,
- Executive branch policy decisions, and
- Judicial interpretations that deal with pesticides and their potential to impact water resources. Legislation sets goals and provides the framework which guides federal agencies in executing prescribed programs.

5. Water quality in South Africa

Water quality is impacted both by natural processes, such as seasonal trends, underlying geology and hydrology, weather and climate, and by human activities, including domestic, agriculture, industry and environmental engineering. 75% of Africa's drinking water comes from groundwater16 and is often used with little or no purification. Water contaminated by microbiological pollutants spread diseases such as dysentery, cholera and typhoid. Chemical contaminants, including those naturally found in the underlying bed rock, can also cause disease and developmental problems, and can adversely affect agricultural yields and industrial processes.

The United Nations Environment Program (UNEP) has recently set up GEM Stat database, dedicated to water quality. The database includes data for all regions in the world including Africa, and contains information about physicochemical parameters (e.g. pH), nutrients, major ions (including metals), organic matter and organic contaminants, together with microbiological and hydrological data. However, the data collected for Africa is only limited to specific regions and in many cases does not give a detailed assessment

of the sources of ground and surface water. Many important water bodies, which provide water for drinking, washing and irrigation for many thousands of local inhabitants, are showing unacceptable levels of potentially toxic substances . These include heavy metals, persistent organic pollutants (POPs) and biological contaminants .These pollutants originate from a variety of sources, including local industries and domestic waste water.

Access to clean drinking water and basic sanitation, including toilets, waste water treatment and recycling, affects a country's developmental progress in terms of human health, education and gender equality.

Provision of potable water varies amongst urban, rural and peri -urban dwellers. The middle- and upper-class urban dwellers receive water from major rivers, dams and deep well

Sources . Most of Africa's rural and peri-urban water-needy depend on smaller tributaries and catchments and seasonal rivers.

Not surprisingly, African towns and cities have better water supplies and sanitation services than rural areas, yet two thirds of the African population live in the countryside. An estimated 82% of urban residents in Sub-Saharan Africa have access to safe water and 55% to sanitation facilities.

6. Water Quality in South Asia

85% of drinking-water in South Asia meets the target of the Millennium Development Goal of coming from an improved source, this water is, in fact, frequently contaminated with human faecal organisms. The failure to deliver clean water to the population of South Asia means more childhood deaths, less cognitive development, less educational achievement, and less economic growth.

Improving the water quality throughout South Asia is difficult. Interventions to improve the water quality are generally implemented by water engineers. The health impact of these interventions is less-commonly assessed.

The problem of water quality does not end with microbiological contamination. Groundwater, especially shallow groundwater, in many sites in South Asia is contaminated with dangerously high levels of arsenic. Long-term exposure to the high levels of arsenic in drinking-water reduce child survival, and lead to cognitive impairment , cardiovascular diseases , and cancer. Although many approaches can remove arsenic from drinking-water, there is much less evidence available that these interventions can be introduced at scale and that their introduction is associated with a reduction in arsenic exposure of humans and improved health.

In addition to human enteric pathogens and arsenic, drinking-water in South Asia can also be contaminated with industrial pollutants. The South Asian economies are developing. This means that a progressively smaller percentage of the workforce is engaged in agriculture, and more of the economy is devoted to industrial production.

7. Conclusion

1) The water quality situation is highly variable in developing countries reflecting different levels of development and different needs for water quality programs.

2) The conventional paradigm of data collection is not well suited to developing countries and is being abandoned by some developed countries as being too expensive, inefficient and ineffective.

3) New technologies in data collection and in the application of knowledge-based approaches to environmental problem solving offer new hope for data-poor countries.

4) Institutional change, including rethinking of the centralized monitoring model and the devolution of core monitoring activities to the community level, offers opportunities for cost savings and higher levels of response to the public.

5) Protection of ground and surface water quality is critical to economic viability, as well as human health and environmental quality. Although pesticides are essential in the production of an adequate ,economical food supply, rural (agricultural) as well as urban uses loom as possible sources of water contamination.

6) In Africa the available data suggests that water quality is declining, but there is a pressing need for more data to be collected.

7) In south Asia, there are microbiological contamination , Groundwater contaminated with high level of arsenic and industrial contamination of drinking water ,so,this need a renewed commitment to water quality and improved water quality among this region.

8) Models of capacity building, especially for the rapidly expanding needs of water quality remediation, need to be re-examined so that there is genuine enhancement of in-country intellectual and technical capacity that is needed to break the cycle of dependency on foreign organizations and companies for most advanced work.

9) We need also to break the dependency on conventional approaches towards lake and river restoration such as data-intensive modeling, dredging, and expensive engineering solutions for algae control, by focusing on innovative alternative approaches that are cheaper and more sustainable.

10) In many developing countries restricted funding is one of the restriction in water quality programs.

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