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Water Management: Need of the Country

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Abstract : Water today, defines human, social and economic development. Without adequate supplies and management of fresh water resources, socio-economic development simply cannot take place. Population growth is expected to result in a decline in the per capita availability of fresh water. It has been estimated that by 2017 India will be water stressed. About 85% of rural population in India is solely dependent on ground water, which is polluted with several geogenic and anthropogenic contamination. Chemical contamination namely fluoride, arsenic and selenium pose a very serious health hazard in the country. It is estimated that about 70 million people at risk due to excess fluoride and around 10 million people are at risk due to excess arsenic in ground water. Pollution of ground and surface waters from agro-chemicals (chemical fertilizers and chemical pesticides) and from industry poses a major environmental health hazard. People are suffering with various debilitating illness (including cancer- Punjab state) due to consumption of contaminated water. Suffered people mostly belong to poor status and cannot afford water purification techniques.

The Ministry of Agriculture should promote the adoption of sustainable natural farming methods and move policies away from the use of chemical inputs. The pollution Control Board must ensure that the industry specific standards on industrial effluent discharge quality, as outlined within the Environment Protection Act 1986 are adhered to by all industries. Non- complying industrial plants must be closed until suitable effluent treatment plants are installed. Watershed development can become an acceptable unit of planning for optimum use and conservation of water resources and needs to be implemented extensively across the country.

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. Ironically, 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. It is only since United Nations agencies 1998 meetings of the Commission on Sustainable Development, the General Assembly, and other organizations began looking at the overall contribution of massively polluted water to the global water crisis that the world has started to take water quality seriously (Ongley, 1994). The contribution of water quality to this crisis is mainly through the loss of a wide variety of beneficial uses, including large-scale ecological dysfunction and collapse, loss of economic opportunity and its role in public health and poverty. Water quality is also intimately linked to the issue of sustainable food production. Fresh water is needed for drinking, producing food and washing. It's used in the manufacture of many industrial products and for generating power. It's essential for ensuring the integrity of many ecosystems. Demand for fresh water is rising: the consequence of a growing world population and increasing demand in developing countries. Yet in many areas of the world fresh water supplies are either scarce, are being over extracted, or are unfit for use because of pollution. By 2025 around 3 billion people are expected to live in places where fresh water is in short supply.

In 2007 our group reported discharges to water were around 61 thousand tonnes which was just over 32% higher than our 1999 levels. Discharges to water can vary greatly depending on our drilling activity as we explore for new energy resources worldwide. Drilling discharges to water in 2007 were nearly 51 thousand tones, a value comparable to our 2006 discharges (Ongley, 1997; 1998; Ongley and Booty, 1999). The impact of our discharges is mainly upon the local receiving waters. In 2005 we changed some of our reporting categories to improve the way we describe our discharges. We are now consolidating the waste water load from our refining and manufacturing plants in terms of the widely used environmental parameter of Chemical Oxygen Demand (COD). We are also reporting the volume of waste water that we discharge. In addition, we now show separately the waste water that we send for treatment to third party treatment plants.

As part of our drilling activities we discharge rock cuttings and drilling muds. Water based drilling muds are the least damaging to the environment when compared to oil based or synthetic based alternatives (Ongley and Ordonez, 1997). In 2001, we phased out the discharge of oil based drilling muds to water. In 2007, discharges of synthetic base fluid in drilling muds and cuttings, from our E&P drilling operations, increased significantly: 2007 discharges, at around 4 thousand tonnes, were 79% higher than those in 2006. However, these are still 30% lower than those in 2001. 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 (Allan, 1995; Christmas and Roy, 1991;Churchill, 1996; Danieli and Stamatopoulou, 1999; Esrey and Habicht, 1986). In 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 (Gleick, 1996). There are, however, some common denominators in the types of actions that are required for sustainable solutions. The challenge for national and multilateral agencies, and the subject of this paper, is how to carry out water quality control and remediation programs that are cost-effective and sustainable.

The increasing scarcity of water in the world along with rapid population increase in urban areas gives reason for concern and the need for appropriate water management practices. Very little investment has been made in the past on sewage treatment facilities; water supply and treatment often received more priority than wastewater collection and treatment. However, due to the trends in urban development, wastewater treatment deserves greater emphasis. Currently there is a growing awareness of the impact of sewage contamination on rivers and lakes; wastewater treatment is now receiving greater attention from the World Bank and government regulatory bodies. According to the World Bank, "The greatest challenge in the water and sanitation sector over the next two decades will be the implementation of low cost sewage treatment that will at the same time permit selective reuse of treated effluents for agricultural and industrial purposes". It is crucial that sanitation systems have high levels of hygienic standards to prevent the spread of disease. Other treatment goals include the recovery of nutrient and water resources for reuse in agricultural production and to reduce the overall user-demand for water resources.

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

India can prevent an impending water stress situation by integrating its regional water management programs at the national level

India recently recognized the need to manage existing water reserves in order to avoid future water strain; however, for a country of such vast geographical expanse the initiatives taken so far are too few and too spread out. India would benefit from establishing an independent central regulatory agency to design, control and coordinate national programs for water conservation (Glibert et al., 2008; Diaz and Rosenberg, 2008; Hutton et al., 2007; Jenkins et al., 2009). Government policy changes (such as those mentioned) below would also ensure that water management techniques and initiatives are executed at a national level across sectors

Agricultural Sector

Improve water usage efficiency in the production of water-intensive crops such as rice, wheat and sugarcane; encourage adoption of techniques such as rain-water harvesting and watershed management in agriculture. Reduce subsidies on power and implement customized pricing models to counter groundwater exploitation through excessive withdrawal.

Water use in agriculture

In many developing countries farmers use, on average, twice as much as water per hectare as in industrialized countries, yet their yields can be three times lower - a six-fold difference in the efficiency of irrigation. On top of this, only one-third of all the water withdrawn for agriculture actually contributes to making crops grow - of the remainder some is returned to the system and reused but much is polluted or unusable. Added to this inefficiency in use, aquifers are being depleted faster than they are being replenished. This is particularly the case in China, India, Mexico, Thailand, North Africa and the Middle East (Kan. 2009; Marshall, 2005; Martinez et al., 2007; Lange and Jiddawi, 2009; Miri and Chouikhi, 2005). Also intensive pumping can deteriorate the quality of groundwater by attracting salt water either from the sea or from naturally saline groundwater.

Managing water resources for agriculture

Improved agricultural irrigation could reduce water use by between 20% and 30%. Options include:

(i) Pricing agricultural water to encourage conservation.
(ii) Using lined or covered canals that reduce seepage and evaporation.
(iii) Developing computer monitoring and scheduled release of water for maximum efficiency.
(iv) Integrating the use of surface water and groundwater to more effectively use the total resource.
(v) Irrigating at times when evaporation is minimal, such as at night or in the early morning.
(vi) Using improved irrigation systems, such as sprinklers or drip irrigation that more effectively apply water to crops.
(vii) Improving land preparation for water application.
(viii) Encouraging the development of crops that require less water or are more salt tolerant.

Industrial Sector

Encourage investment in recycling and treatment of industrial wastewater through regulations and subsidies for water treatment plants.

Domestic Sector

Implement policies to make rain-water harvesting mandatory in cities with new construction projects.

Contemporary needs

India promulgated its latest National Water Policy in 2002. This policy emphasizes the planning, development and management of water resources on river basin scale for optimum utilization. The integrated development of any river basin poses considerable technical and financial challenges. The emphasis is on the investment in the projects vis-à-vis the benefit cost ratio for rational, multipurpose use of water and other resources; on constraints to development and on ways to mobilize human resources and deal with ecological aspects, in order to carry river waters in adequate quantities to where they are perceived to be required. Increasing urbanization is also posing serious pressure on the available water resources. Development of water resources is thus causing an adverse irreversible impact on conservation of rivers ecosystems. To minimize the changes and reduce the damage to the river systems, it is necessary now to have one national level organization to manage the river basins.

Reorganization of the Water Resource Management (WRM) structure

Any reorganization of the WRM structure will have to take into consideration the existing national water policy, state level policies, organizational structure, and the statutory provisions. Any new proposed system of River Basin Organizations (RBOs) should cause minimum turbulence in the existing command and control situation to ensure smooth transition to the new system. The RBOs need to be equipped with a knowledge base, ability and regulatory authority to execute plans for the balanced exploitation of all facets of water resource utilization -irrigation, hydropower, fisheries, tourism, ground water, soil conversation, inland water navigation - for the planned growth of future population centers.

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 and therefore have no notion of which is of greatest economic or public health significance. Usually, freshwater quality management is completely divorced from coastal management even though these are intimately linked. 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 the following water quality components:

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 the following components:

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

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

(iii) 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.

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

(v) 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.

(vi) 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.

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

(viii) A methodology for public input into goals and priorities.

3. Education System in kindergartens, schools and universities.

DESIGN ISSUES IN WATER QUALITY MONITORING

The first design criteria in any water quality program are to determine what management issues for which water quality data are required. The technical aspects of data collection will flow from this decision, especially as there are now very cost-effective alternatives to conventional monitoring practice. Establishing of data objectives in Mexico, for example, resulted in a radical shift in national monitoring practice which produced the savings noted above. In addition, these new methods will permit a much higher level of regulatory compliance. Most importantly, data programs are now seen to have value insofar as they will provide a service for someone other than the monitoring agency itself. Entries in the following categories may shift between categories, depending on the situation.

(a) Descriptive data that are typically used for government policy and planning, meeting international obligations, and for public information.

(b) Data specific to public health.

NET WORK DESIGN

In general, technical innovation has had a major impact on the design of monitoring networks. Contrary to practice in most countries the three types of data noted are not cost-effectively provided under a single type of monitoring protocol. For example, the conventional fixed-site network is adequate mainly for production of descriptive information that is useful for public information and for broad policy issues. Generally, however, such networks are of little value for regulatory purposes, for determining management options in cases of aquatic pollution, or for related investment decision-making (Nyenje et al., 2010). For this latter group of issues, technical innovation and progress in our scientific understanding of cause and effect has provided a broad range of diagnostic and analytical tools that make regulatory monitoring and enforcement cheaper and easier, and more enforceable in courts of law. The conventional concept of a national water quality network operated by a (centralized) national agency is probably not appropriate in many developing countries that have neither the economic nor technical resources to operate a national network. The fixed site network that is recommended by most water agencies is expensive and inflexible, especially as many priority issues can be more effectively dealt with by the more flexible survey approach (Tilmaan, 1998). For a substantial number of less advanced developing countries and regionally within some more advanced developing countries, where the priority water quality issue is that of public health, there is further reason to rethink the conventional model of a national network of water quality stations operated by a central agency. In many countries, this type of network is not able to provide timely public health data to communities due to limited budget, small number of stations, poor communication facilities (Von, 2005). An alternative model is to develop community-based monitoring of drinking water supply. Canada's International Development Research Centre (IDRC, 1999) has developed a basic monitoring protocol for application in under-developed Latin American and Asian countries by school children and administered over the Internet. In this approach, simple indicators of bacterial pollution are used by each village on its own water supply. Using a simple concept of risk, the community decides if treatment is necessary or, if the water has been treated, whether or not the level of treatment is satisfactory. The essential requirements are for the creation of a community-based group that takes responsibility for water quality, and provision by donors or by the central government of the basic supplies and quality assurance required to operate the program. This approach also requires a shift in thinking from conventional analysis which, although it provides accurate indications of bacterial contamination, is largely unavailable to local populations, to a risk-based approach that identifies the potential for health effects but which is easily implemented at the local level.

INSTITUTIONAL AND LEGAL ISSUES

In addition to economic uncertainty, many of the problems of water quality monitoring and management are institutional in nature and are too broad to deal with detail in this paper. The principal institutional issues tend to be:

1. Isolation of the data collecting agency from users of water quality data.
2. Overlapping mandates and inter-institutional competition.
3. Failure to institutionalize adequate quality assurance and quality control over data.
4. Lack of communication protocols and/or facilities for transmitting data/information to users.
5. Uncritical acceptance of training that is not focused on priority issues.
6. Lack of human resource strategies to build and promote competence.
7. Uncritical acceptance of donor assistance – this tends to be seen in
8. Donated equipment which can not be sustained due to lack of skilled personnel, maintenance, spare parts or reagents.
9. Lack of follow-up by the donor.
10. Unwillingness to accept low technology solutions even when these are more sustainable and suited to local skills, etc.

As noted by Ongley (1998) efficient water quality management is usually severely hampered by out-dated legal requirements that cover everything from sampling and analytical protocols, to data standards. The most difficult issues tend to be:

1. Out-dated legal requirements calling for specified water quality parameters. One example is dissolved metals which have been abandoned by most western countries (at least for routine monitoring) due to insurmountable field and laboratory errors.

2. Codification of analytical methods which locks programs into out-dated methodologies which cannot take advantage of new and more cost-effective techniques.

3. Codification of analytical quality assurance and quality control (QA/QC) which, in fact, does little to ensure reliable data in the absence of compliance assessment and enforcement. Unfortunately, codification for QA/QC and for analytical methods, appeals to bureaucrats because of its administrative simplicity.

4. Lack of data standards so that there is no ability to develop national data sets using diverse data sources and, therefore, no ability to produce reliable national perspectives on water quality. Uncritical acceptance and codification of water quality standards (usually western standards) that are inappropriate to the local situation and are unenforceable.

Some Solutions for Sustainable Capacity Development

A major objective should be that the foreign consultant (or company) becomes the facilitator and not the "doer" so that real capacity is developed in-country. It is true that 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. Usually this consists of workshops, short training, and access via computer-related technologies (the Internet, etc.). This works well for simple technologies that can be learned quickly or for which the underlying principles, if not the actual mechanics, can be easily grasped. 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. Three alternatives for technology transfer for complex problems are provided below:

(i) Using knowledge-based (K-B) techniques (a form of information technology), including appropriate computer-based decision-support systems (this is not GIS), it is now possible to put the essential domain knowledge in the hands of a decision-maker in a way which is focused on a particular type of problem (Ongley & Booty, 1999). It is particularly suited to data-poor environments where the application of domain knowledge can often replace extensive and expensive data collection. K-B techniques can deal with the uncertainties in the decision process, including uncertainties rising from the types of data/models/assumptions being used. In the nearer term, K-B techniques are probably most useful in scoping a particular problem, identifying information gaps (and the relative importance to the possible outcomes of these gaps), and selecting from amongst various implementation options. Such systems can be mounted on central web sites and accessed on-demand, or included in distance learning programs as a way of focusing the learning process on particular problems and their solutions.

(ii) A second approach is to reconsider the type of business model that is used to access foreign expertise. A business model is a good one for complex issues insofar as companies have the ability to retain or attract the necessary expertise, can keep abreast of new developments in the technology, can raise capital and offer performance guarantees, understand project management, and provide longer-term stability. The problem is, however, that typically the foreign company does the work with some, often low-level, input from local partners that are acquired on a one-time basis primarily to win a contract and, once the job is finished, the firm goes home leaving little real capacity in-country. A better business model is one in which companies nurture local partners within an equity or royalty framework, so that local firms increasingly can compete for the work, but retain ties to the core expertise and knowledge that may lie outside the country. Lending institutions and in-country agencies with contracting-in responsibilities can influence this type of nurturing by using nurturing criteria within the bid selection process.

(iii) Thirdly, given the growth in complex remediation requirements in Asia, Latin America Eastern Europe, and parts of Africa, there would be merit in introducing an extensive, multi-disciplinary, educational process within large remediation programs. The education process would use the real-world example as a learning environment. This could be included in, for example, GEF projects although it is noted that the GEF does not fund education *per se*. A project in, for example, Asia could train technical staff from various Asian countries in both the technical and managerial practices of a remediation program. Such a program could have degree status within an existing Asian academic institution. The focus might include both scientific and project management aspects.

FINANCING AND SUSTAINABILITY

Financial sustainability is a difficult issue, especially in less advanced developing countries. Generally, in the first-instance, it requires a well-defined and targeted program that meets specific management needs. This will drive local and donor activities and will avoid wasteful investments that are not directed to national goals. Some specific considerations for financing and sustainability include:

(a) Focusing Donor Assistance: Often donor assistance is focused on the donor's preferences for technology (as in tied aid projects) and actions. Closer control over, and scrutiny of, donor assistance and, in particular, the use of low technology approaches, offer greater potential for sustainability once the donor project is completed.

(b) Regional Partnerships: Regional centers, funded by donors on a sustained basis, has a much greater chance of success in offering low cost training, quality assurance, and certain types of analytical services that should not be implemented by each country. Such centers, because they can access a large market for laboratory and environmental services, have potential for commercial and profitable linkages with (western) environmental and laboratory service companies that could make these centers self-supporting.

(c) Public-Private Sector Partnerships: Contracting-out of monitoring and analysis makes economic sense in some developing countries because of greater efficiency in the private sector. An alternative is the operation of government laboratories by private companies under contract to the government. In countries where there is some enforcement of environmental standards, there is potential for commercial linkages with western laboratory service companies.

(d) Quality Assurance and Quality Control (QA/QC): This merits special attention as it is amongst the most difficult of objectives to finance and sustain. QA/QC is essential to data programs, is inexpensive, yet donors are reluctant to fund this activity. QA/QC programs are only effective when operated regionally or locally, hence it is necessary to fund a regional centre(s) to carry out this activity on behalf of member states. One possible method of funding is to require that all externally funded water programs contribute some small percentage of budgets to a designated regional centre that will provide QA/QC services to member states.

(e) The principle of selling national data is well established, despite opposition from certain international organizations. An option for government monitoring agencies is to market their data to developers and international project managers. Clearly, the data must first meet high standards for data quality. A parallel approach could be to require foreign projects to purchase data services from domestic sources rather than importing their own analytical capabilities or exporting samples to their own countries for analysis.

In countries with significant potential for this type of business, a commercial linkage between local agencies and foreign laboratory service companies would make very good business sense and would provide a high level of quality assurance to international projects.

CONCLUSION

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

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