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REDESIGN AND MODERNIZATION OF THE MEXICAN WATER QUALITY MONITORING NETWORK

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ABSTRACT

Mexico is a large developing country, much of which is arid and semiarid. With a population of more than 81 million Mexico is confronted with growing water scarcity and serious pollution of much of its surface water. The National Water Commission (Comisión Nacional del Agua – CNA) has embarked on a major program of modernization of water management. The water quality program, now consisting of 564 surface water stations (+ 239 groundwater stations), has no strategic design, has major data gaps, is not representative of important areas, is often unreliable, does not contain data for many current issues such as organic contaminants, and suffers from out-of-date or lack of facilities. Because the existing network is not representative of the range of issues for which data are needed, network redesign began from first principles rather than an optimization of the existing network. The new program is built around client needs, and uses four components – a primary network of some 200 stations which are designed to characterize important water bodies over the long term; a flexible secondary network that focuses on effluent regulatory issues; surveys and special studies for river basin planning and issue-specific purposes; and a mobile emergency capability. Modernization of the water quality program also includes parallel activities focusing on training, institutional and legal issues.

Key Words: water quality, developing countries, modernization, monitoring

INTRODUCTION

Mexico is a large country of 1,958,201 km² with a population in 1990 of 81 million inhabitants unevenly distributed across the country. Some 15 millions live in the metropolitan area of Mexico City itself [1]. Mexico is land of stark contrasts in water supply and use. With the exception of the south of the country which is tropical, the rest is arid and semiarid with large concentrations of urban, industrial and irrigation activities.

The total precipitation in Mexico is approximately 1,522 km³ per year [2]. Surface runoff is 410 km³ of which the installed hydraulic storage capacity is 120km³. Natural recharge of groundwater is 48km³ per year. Excluding water used for hydro-electric power generation, total water extraction is 72.2 km³ annually (Table 1) of which one-third is from groundwater and the balance from surface water. The interaction between surface and groundwater is complex and important from a water quality perspective, but is not the substance of this paper.

Table 1 indicates the importance of agriculture in total water consumption, comprising some 88% of the national total. Agriculture provides 46% of total discharges to surface water and is presumed to be a major source of nutrients and pesticides to surface waters. While total discharges are only 04% of total surface runoff, the concentration of population and industrial activity in the Mexican heartland where natural runoff is largely confined to the summer wet season, creates situations where wastewater can comprise a significant percentage of surface flow during the dry season. In other areas such as the Yucatán Peninsula, karstic terrain creates a shallow groundwater system which is highly vulnerable to rural domestic effluents and municipal wastes that are discharged to the groundwater.

Table 1: National Water Extraction, Consumption and Discharge

USE	Extraction km ³	Consumption km ³	Discharges km ³
Agriculture	55.5	46.6	8.9
Industry	9.3	3.7	5.6
Urban	7.4	3.5	3.9
Hydroelectric	128.8	----	-----
TOTAL	185.0	53.3	19.2

Source (1) citing CNA, 1993.

Mexico has been rapidly adding to its installed capacity for wastewater treatment. In 1994 some 24% of total wastewater is subject to some level of treatment although problems of plant operation and maintenance remain a problem. Nevertheless, large scale pollution of surface and subsurface waters in much of the country remains a serious public health and ecological concern. From a public health perspective, the most serious issue remains one of bacterial contamination which is significantly associated with morbidity and mortality from gastroenteric diseases. Outbreaks of cholera continue to plague the country. Although not well monitored, it is known that water pollution by heavy metals and synthetic organic contaminants are serious issues in industrial parts of the country. Nutrient pollution from municipal effluents, from agricultural runoff and from food processing industries causes serious eutrophication of surface waters. It is highly probable that surface and groundwater are impacted by pesticides used in irrigated and dryland agriculture, and which are used to control water hyacinth in some reservoirs. Periodic and major duck mortalities in lakes and reservoirs are likely linked to botulism which, in turn, is linked to eutrophication.

Water management in Mexico was systematized in 1992 under a new National Water Law. Water quality monitoring is one of the many water programs carried out in Mexico by the National Water Commission (Comisión Nacional del Agua [CNA]). The CNA was created in 1989 to provide an integrated, national, water management organization. Formerly in the Ministry of Agriculture, CNA

was transferred in December, 1994, to the Mexican environment agency (Secretaria del Medio Ambiente, Recursos Natural y Pesca - SEMARNAP). CNA discharges many, but not all, of the responsibilities of the Mexican Government in the latter's capacity as "owner" of all water resources of the country. The principal responsibilities include:

- * Develop the infrastructure required meet new water demands in a timely manner.
- * To promote efficiencies in water use.
- * To give priority to the control and reduction of water pollution.

CNA has responsibility for measurement and operations in the fields of meteorology, hydrology, water quality, groundwater quality/quantity and aquifer management, and a large number of dams and reservoirs. CNA also manages the water extraction and effluent permitting process and collects permit fees and pollution fines. Although CNA exercises certain legal powers such as establishing site-specific effluent criteria (*condiciones particulares de descarga*), the authority to establish national standards for effluents (*las Normas Oficiales Mexicanas*) rests with the National Institute of Ecology (INE) with input by CNA and other organizations. In contrast, the authority to establish national standards for laboratory accreditation is exercised by the Ministry of Commerce and Industry with input from a variety of government organizations and other stakeholders.

It is against this background that the CNA carried out an assessment of the existing operational programs and the historical information base that was available for water management and planning. It was concluded that the information base had no strategic design, had major gaps, was not representative of important areas, was often unreliable, and suffered from out-of-date or lack of facilities. Operational programs needed to be re-examined for cost-effectiveness and linked to priority requirements for data. Institutional development and training were also identified as priorities. This review led to the creation of the "Project for the Modernization of Water Management in Mexico" (*Proyecto para la Modernización del Manejo del Agua en Mexico* - PROMMA) [3] with implementation over the period 1996-2001. The technical content of PROMMA was developed by national experts with assistance from foreign consultants. Funding for PROMMA is a matching funds agreement under a loan from the World Bank.

Significant for the modernization of water quality management is the observation that expertise and experience in environmental chemistry and toxicology in Mexico is much more limited than in North America or Europe. At the same time, Mexico is facing all the same types of issues that occupy water agencies in Canada and the United States, and for which Mexico has certain obligations under NAFTA. This creates a unique challenge in that modernization of water programs must include significant capacity building that can be assimilated and used to advantage by Mexicans. This requires a balance between what is desirable and what is effective and achievable in the Mexican situation.

The surface water quality program, the focus of this paper, consists of three major components: monitoring networks, laboratory systems, and information systems. This paper will address primarily the monitoring networks with limited reference to the other components. The groundwater monitoring program is discussed by Steele et al. in this volume. The overall framework for the water quality program, that is, the rationale for a water quality program and how it links to the data needs of stakeholders, and the importance of water quality within a national economic and social framework,

was the basis for redesign of the monitoring program. This framework is presented in detail by Garcia et al. in this volume. The present paper will deal with the decision process that led to an implementation plan for monitoring redesign and modernization in Mexico. While all the components of a modernization program [4] and the decision-process described here have broad applications to modernization and redesign of water quality monitoring in developing countries, the implementation plan for network redesign described here is specific to the Mexican situation and would require evaluation for its suitability in other countries.

STATUS OF THE CURRENT MONITORING PROGRAM

CNA has specific responsibilities for water quality data in the following programs:

- * Monitoring and characterization of surface and ground water.
- * "Clean Water" program (water supply monitoring, hospital wastes, etc.).
- * Control of aquatic weeds.
- * Regulation and enforcement of discharges.
- * Water Quality Studies.

The current network of 564 surface water stations is an inherited network which has grown through more than 20 years without a systematic basis. Sampling frequency is variable, from monthly to quarterly, depending on budget and location, but may have prolonged data gaps when funding is curtailed. Monitoring uses a standard list of microbiological, nutrient, major ion, and indicator parameters. Data on metals are not widely collected. With the exception of some pesticides, organic contaminants are not normally collected due to lack of analytical capability in CNA and until recently, more broadly, in Mexico. There is no systematic QA/QC applied to field programs. As a general summary, the current water quality program was designed to meet the needs of the 1960's. The inherent problems of such programs, which are very common in developing countries, in meeting contemporary information needs for environmental planning and management, including investment planning, policy development, and regulatory control, are more fully discussed in Ongley [5].

Additionally, most CNA laboratories are old and many are dysfunctional because of lack of modern instrumentation and chronic underfunding. There is no national reference laboratory for the setting of standards, for developing and applying a QA/QC regimen, or for developing standard operating procedures. There is no systematic QA/QC applied across CNA laboratories or to private sector laboratories that supply data to CNA; generally, the level of expertise in environmental chemistry and toxicology is inadequate for modern water quality management needs. Under PROMMA there is a complete plan for modernizing the laboratory program and for developing a QA/QC program that will apply not only to CNA laboratories but also to private laboratories that provide data to CNA. The framework for the laboratory program is tightly linked to the field monitoring program, including a costing analysis of sample types and quantity that was used to derive the minimum number and types of laboratory facilities required to service the country. The laboratory component will not be addressed further here.

CNA has developed an impressive interactive information management facility at its water quality headquarters using the PC-based RAISON system. Similar capability was largely non-existent in 1995 in regional offices but is now being addressed. Expansion of data management facilities with enhance capabilities, including a wide-area network, is planned under PROMMA and will link the various activities and offices of CNA.

REDESIGN OF THE SURFACE WATER QUALITY NETWORK

One part of modernization of monitoring [4] is the redesign of the monitoring network. Redesign is usually more than an exercise in network optimization; redesign begins with the premise that the existing network is probably not a good basis for planning a new network. Therefore, network redesign has the following objectives:

- Targeting monitoring to specified management and user objectives
- Reduction and simplification of parameters
- Optimizing monitoring sites
- Use of a blend of alternative approaches (fixed-site, surveys, etc.)
- Elimination of activity overlap amongst different agencies having similar responsibilities (not the case in Mexico)
- Enhanced efficiency of operations (field and lab).

Information Needs

The following *issues* are those which mainly determine data needs in Mexico.

1. Status & trends of important water bodies
2. Conformance of water bodies to use-specific water quality objectives
3. Identify contaminants requiring control measures
4. Efficacy of effluent control measures
5. Basin surveys for specific issues
6. Emergency measures - spills, etc.
7. Public health issues
8. Maintain fisheries
9. Maintain sensitive ecological areas
10. Transboundary issues
11. Waters of touristic value

Management needs largely relate to policy and planning, regulatory control, investment planning for water infrastructure, public relations and international obligations.

Planning Assumptions

It is essential that the monitoring network be cost-effective, be able to effectively respond to the main management issues of CNA, fulfil the legal requirements of CNA, and be sustainable in the long term. Therefore, the planning assumptions that have been applied are:

- a. The monitoring program exists as a **service** to CNA, to other clients, and to the public.
- b. Monitoring activities must always be dictated by clear articulation of data and information needs by CNA and by other "clients".
- c. The monitoring program should be carried out on a business-like basis. Experience shows that open-ended "free" services lead to excessive data collection and analysis, and which is not effectively used by the clients of the program.
- d. Monitoring methodologies and associated capacity building must be suitable to the Mexican situation.
- e. Any redesign must build in the requirement for continuing re-evaluation and adjustment of the network.

Principles of Network Redesign

It was clear that a single, fixed-site network would not provide the types of information required to fulfil all the CNA responsibilities, nor to satisfy the needs of the various stakeholders. Therefore, the objective of network redesign was to (Table 1):

- a) Rationally reduce the large permanent network to a limited **primary network** of stations that would provide long-term descriptive information on the status of important or sensitive water bodies. The data would also characterize water quality in a way that reflected broad categories of user requirements for surface water and, hence, provide a useful reporting framework for political and public use. The target for number of stations is 200 in the expectation that this limited number is sustainable in the long term.
- b) Provide a flexible "**secondary network**" that can respond to regulatory needs. These stations would be located, usually temporarily, in receiving water bodies in highly impacted areas so that efficacy of end-of-pipe regulations can be verified, or which can provide forensic evidence of contaminants that are not in the Mexican norms for effluent control and which should be considered for control.

Table 1: Components of redesigned national monitoring network for surface water quality.

NETWORK TYPE	FUNCTION	CHARACTERISTICS	PRINCIPAL CLIENTS	EVALUATION OR REGULATORY TOOL
PRIMARY	Long-term	Approximately 200 long	Government, Users,	Water quality objectives

NETWORK	characterization of principal water bodies, including factors such as significant recreation, conservation or political (e.g. frontiers) concerns.	term fixed sites, suite of standard parameters + site-specific parameters. Sites will avoid areas immediately downstream of major effluent impacts; river sites located to provide an integrated view of upstream activities.	Stakeholders, Public	
SECONDARY NETWORK	Regulation and control of effluents	Short or long-term stations in receiving water bodies, flexible, river reach and effluent-specific parameters including regulated parameters and forensic tools such as TIE; sampled media (water, sediment, biota) according to need); number of stations according to need and budget.	Regulatory authorities	Water quality criteria or objectives for mixing zones; studies and reports required by law to justify changes in effluent standards.
SPECIAL STUDIES	(1) River basin characterization for planning purposes (2) Issue-specific studies	Scheduled surveys rotated over 5 year periods Surveys or scientific studies; scheduled or responding to issues	Government (all levels), Public Government, Stakeholders, Public	Reports Reports
EMERGENCIES	Crisis situations such as spills, public health crises.	Mobile response capabilities	Government, Public	As applicable to situation

- c) Make use of surveys and special studies to "fill in" the knowledge base for issue-specific concerns and for basin planning purposes.
- d) Provide an emergency response capability in industrialized areas for accidents such as spills.

As part of the redesign we recognized that there was a need to move away from the traditional and very expensive chemical-list approach to monitoring (especially for trace organics) and to find simpler and more economical measures of diagnosing and describing water quality. Fortunately, there are many new diagnostic tools and field and analytical methods that:

- * Simplify parameter schedules to save money,
- * Provide screening information to determine which samples merit further analysis,
- * Use inexpensive "indicator" parameters that are more easily interpreted than measures of individual chemical concentrations,
- * Reduce and/or eliminate unnecessary and costly chemical analyses,
- * Produce data that are relevant to clients
- * Increase efficiency in entire program

Implementation of the Redesign Process

Network optimization using existing monitoring data rests on the following assumptions and has certain strengths and weaknesses.

Assumptions: Current data programs reflect important water quality management concerns and include appropriate selection of parameters.

Strengths: Good time series data over long periods; usually good range of conventional parameters.

Weaknesses: Tend to be descriptive rather than prescriptive; assumes that existing stations are relevant to contemporary water management issues and that all major issues can be dealt with by a fixed-site network; eliminates survey and occasional data which are relevant to particular problems; does not include a range of new monitoring methodologies and non-traditional data types such as sediment chemistry or toxicity values or biochemical indicators of pollution; assumes that data gaps compromise the ability to resolve water quality management issues (may not be true); often assumes that "more of the same" is "better" (usually not true); assumes that major water management issues can be identified through analysis of historical data records and resolved by adding to these data programmes.

Because of the lack of an historical rationale for the existing network, the lack of data on many current issues (e.g. toxicity, metals, organic contaminants), and the need to respond to new regulatory requirements, we rejected a redesign processes based on an optimization of the current network. For each of the two major types of needs – long-term characterization and short-term regulatory requirements, the redesign process is outlined below. This process is now being implemented and is expected to take two to three years to complete.

a) Primary Network:

The target is 200 stations in rivers, lakes and coastal zones, that can provide a broad and useful overview of water quality in Mexico. The primary network is not meant to address all surface water quality management issues but will be supplemented by the secondary network and special studies for the full range of water planning and management issues. The chronology and linkages of the following steps is identified in Figure 1.

1. Re-evaluation of the primary issues to which a water quality program should respond including a dialogue with stakeholders and clients, and a prioritization of important surface water bodies based on socio-economic, demographic, and political criteria. These water bodies can be then classified for monitoring purposes according to major user criteria such as potable water, agriculture, etc. (for details, refer to Garcia et al. in this volume).
2. Examination of historical data for which stations are congruent with those water bodies identified in Step 1. The objective is to determine time-series characteristics (seasonality; variance, co-variance of parameters, etc.) that can help identify appropriate sampling frequencies for those

parameters, and to identify parameter redundancies.

3. Development of a limited, standard suite of parameters for each station group from first principles, plus site-specific parameters determined from field forensic investigations designed to provide background characterization of selected sites (multi-media sampling), to identify specific chemicals of concern (especially for contaminants for which Mexico has little information), and to provide guidance on future sampling protocols (preferred sampling media, useful and inexpensive indicator parameters, measures of toxicity, measures of environmental stress, etc.).

b) Secondary Network:

The secondary network responds, as needed, to regulatory concerns in highly impacted river, lake or coastal sites. The secondary network will assist CNA in increasing its level of enforcement and provide the kind of information CNA now lacks when charging polluters and in winning subsequent court challenges. The steps being taken to develop this network are noted below and the linkages illustrated in Figure 1.

Figure 1: Flow diagram showing components and decision-process of the redesign of the Mexican national monitoring program.

1. Identification of the major impacted bodies of surface water (including coastal situations such as lagoons) using domain expertise from CNA, existing data on effluents, etc..
2. Beginning with five known impacted rivers, select ten impacted reaches for the implementation of a field and laboratory program that will develop a reach profile consisting of: chemistry of concern using measures of productivity, toxicity, fish assessment, and other forensic techniques such as TIE on water and sediments, etc; recommended future sampling protocols for chemistry of concern, including appropriate media, useful indicator parameters, and measures of potential impacts at the ecosystem and human health levels.
3. Based on the experience of the initial ten reaches, an investigative protocol will be developed and applied to other impacted areas according to need and budget, and in consultation with that part of CNA responsible for effluent permitting.

These data will provide guidance to CNA on efficacy of effluent controls (e.g. meeting water quality criteria for the mixing zone), for identification of contaminants that are not, or inadequately, controlled, on the anticipated impacts downstream that could require mitigation (for ecosystems) or treatment (as for drinking water), and for producing information for official reports that are legally required to justify the need for enhanced regulation of effluents.

INSTITUTIONAL ISSUES AND CAPACITY BUILDING PARALLEL ACTIVITIES

The implementation of PROMMA is a major institutional challenge to CNA which recognizes the institutional limitations and impediments to the implementation of such a major program. Although not specifically part of network redesign, a variety of parallel activities are being implemented as part of monitoring modernization.

1. ***Contracting:*** CNA does not have, in-house, capacity to implement the redesign process. Therefore, this work will be carried out by contract. Innovative contracting can be used to bring new capacity to CNA and, for activities such as field programs using new scientific tools, can be used to carry out technology transfer to CNA staff. This implies, however, that great care is taken in formulating contracts and in selecting contractors. In many instances, CNA will demand that local companies have links to foreign expertise, both to ensure that modern science is being applied, and which has the advantage of bringing new expertise to Mexican companies.
2. ***Training:*** This is a high priority under PROMMA as it is recognized that CNA in particular and Mexico in general, does not have substantial experience in the science and technology of modern monitoring. Training is a blend of in-house enhancement of basic skills (e.g. field monitoring); use of foreign technical experts advisors to CNA management and to provide specific training; the creative use of the contracting process, and advanced academic training for CNA staff overseas.
3. ***Educating Users:*** Commonly, users of water quality data tend to be unspecific when asked what kind of data they need. Often, their request is for more of what they have been given in the past,

irrespective of whether it is useful or not. A necessary activity within a modernization program is an educational process directed at major users of data in order to reduce demand for irrelevant information and to more closely align data needs with more modern types of data and data interpretation. Utilization of modern and cost effective monitoring techniques will be unsuccessful unless users understand how these techniques can improve their ability to manage water quality. A good example of failure to match new capabilities with data needs is in the utilization of bioassay data in situations where monitoring agencies generate toxicity-based information for descriptive purposes (e.g. ranking water bodies on basis of toxicity), yet regulatory agencies do not understand how the same data can be used for decision-making purposes for regulatory purposes. One major consequence of this failure is that regulatory agencies continue to use very expensive and often ineffective chemical-specific effluent regulations.

4. ***Developing Effluent Standards:*** A particular challenge for CNA is the development of modern effluent criteria for all industry groups. With the National Institute of Ecology, CNA may either choose a chemical-specific approach or some combination of chemistry and a toxicity-based approach. It is not determined at this time which will be used nor what difficulty the government will have in having new criteria approved as national norms. Certainly, there will be resistance from many industries for changes that require significant improvement (and therefore cost) of their effluents.
5. ***Water Quality Objectives:*** The development of water quality objectives is a responsibility shared with the National Institute of Ecology. While water quality objectives are a desirable management tool, the fact that surface water can be comprised of a large proportion of waste water presents a significant challenge to the development of useful water quality objectives. Currently, Mexican law does not recognize mixing zones, nor is there data on downstream ecosystem impacts of effluents. Therefore, the development of water quality objectives will be difficult. In the near term, especially in view of the length of time that will be required to develop defensible water quality objectives, a more meaningful approach may be to use well-known technology-based effluent standards as the first step in a more comprehensive approach to the assessment of impacts of effluents relative to water uses.
6. ***Creating a Constituency:*** National water quality programs in many countries tend to be disconnected with users of water quality data. The consequence in many countries, including Mexico, is that these programs tend to have lower priority than other aspects of water management. The challenge is to make water quality programs central to the success of national economies as well as to more conventional issues such as public health. Few countries have attempted to demonstrate the cost of pollution to national productivity. In China, for example, Smil [6] estimated that the net cost of water pollution to the national economy in 1990 was 0.4 - 0.6% of GDP. A major factor in success will be in the ability of the water quality program to regularly produce concise and compelling information products that will capture senior CNA managers' attention. It will also be necessary to develop a larger constituency outside of CNA, including major users and the public.
7. ***Accreditation and Use of the Private Sector:*** CNA is the creation of an historically, highly centralized, political system. Mexico is, however, going through a major period of devolution of

authority and decentralization of water management activities. Part of the philosophical change is the acceptance that government can not and should not necessarily provide all services to the public. Within the water quality program there is an acceptance of the need to examine alternative ways of "doing business" including use of the private sector as a means of reducing costs and of reducing in-house demand for scarce human resources. As part of the philosophical change concerning the role of government, CNA will be developing an accreditation process based in part on the Canadian Association of Environmental Laboratories (CAEL), in which both CNA and private sector laboratories will be subjected to a common performance-based set of criteria. Accreditation is a process by which government "sets the rules" but does not have to provide all the services itself.

8. ***Institutional Change:*** As part of CNA's modernization program thirty-one state offices will be reduced to thirteen Regional Offices based on hydrological units. Additionally, basin councils will be developed (three exist now) to ensure stakeholder participation in the water management process. A network of 36 water quality laboratories of varying capacities will be reduced to an hierarchy of laboratories consisting of one national reference laboratory, six regional laboratories of medium level capability, and a number of mobile and fixed laboratories for very basic and time-limited analyses.

CONCLUSIONS

With a population of more than 81 million, Mexico is confronted with growing water scarcity and serious pollution of much of its surface water. The National Water Commission (Comisión Nacional del Agua – CNA) has embarked on a major program of modernization of water management over the period 1996-2001. The water quality program, now consisting of 564 surface water stations (+ groundwater stations), has no strategic design, has major data gaps, is not representative of important areas, is often unreliable, does not contain data for many current issues such as organic contaminants, and suffers from out-of-date or lack of facilities. Because the existing network is not representative of the range of issues for which data are needed, and does not meet the needs for water policy development, regulation and enforcement, or for infrastructure investment planning, it was concluded that network redesign should begin from first principles rather than from an optimization of the existing network.

The principles applied to the redesign process were: the monitoring network must be cost-effective, be able to effectively respond to the main management issues of CNA, fulfil the legal requirements of CNA, and be sustainable in the long term. From a technical perspective, expertise and experience in environmental chemistry and toxicology in Mexico is much more limited than in North America or Europe. However, Mexico is facing all the same types of issues that occupy water agencies in Canada and the United States, and for which Mexico has certain obligations under NAFTA. This creates a unique challenge in that modernization of water programs must include significant capacity building that can be assimilated and used to advantage by Mexicans, yet be realistic within the Mexican context. To promote efficiency and to increase efficacy, the program will move away from the traditional and very expensive chemical-list approach to monitoring (especially for trace organics) and towards a more innovative use of modern toxicity-based measures, screening techniques, and new and more efficient

measures of diagnosing and describing water quality.

The new program is being built around client needs, and uses four components -- a primary network of some 200 stations which are designed to characterize important water bodies over the long term; a flexible secondary network that focuses on effluent regulatory issues; surveys and special studies for river basin planning and for issue-specific purposes; and a mobile emergency capability. Modernization of the water quality program also includes parallel activities focusing on training, institutional and legal issues. A national accreditation program for laboratories is being developed. Creative data synthesis and reporting will be essential for development and maintenance of public and institutional support for the program.

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