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South Asia Transboundary Water Quality Monitoring Workshop Summary Report

Gaurav Rajen, J.David Betsill, Frederick Luetters, and Adriane Littlefield

Prepared by
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SOUTH ASIA TRANSBOUNDARY WATER QUALITY MONITORING WORKSHOP SUMMARY REPORT

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ABSTRACT

The Cooperative Monitoring Center (CMC) promotes collaborations among scientists and researchers in several regions as a means of achieving common regional security objectives. To promote cooperation in South Asia on environmental research, an international working group made up of participants from Bangladesh, India, Nepal, Pakistan, and the United States convened in Kathmandu, Nepal, from February 17-23, 2002. The workshop was held to further develop the South Asia Transboundary Water Quality Monitoring (SATWQM) project. The project is sponsored in part by the CMC located at Sandia National Laboratories in Albuquerque, New Mexico through funding provided by the U.S. Department of State, Regional Environmental Affairs Office, American Embassy, Kathmandu, Nepal, and the National Nuclear Security Administration's (NNSA) Office of Nonproliferation and National Security. This report summarizes the SATWQM project, the workshop objectives, process and results.

The long-term interests of the participants are to develop systems for sharing regional environmental information as a means of building confidence and improving relations among South Asian countries. The more immediate interests of the group are focused on activities that foster regional sharing of water quality data in the Ganges and Indus River basins. Issues of concern to the SATWQM network participants include studying the impacts from untreated sewage and industrial effluents, agricultural run-off, salinity increases in fresh waters, the siltation and shifting of river channels, and the environmental degradation of critical habitats such as wetlands, protected forests, and endangered aquatic species conservation areas.

The workshop focused on five objectives: 1) a deepened understanding of the partner organizations involved; 2) garnering the support of additional regional and national government and non-government organizations in South Asia involved in river water quality monitoring; 3) identification of sites within the region at which water quality data are to be collected; 4) instituting a data and information collection and sharing process; and, 5) training of partners in the use of water quality monitoring equipment.

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SOUTH ASIA TRANSBOUNDARY WATER QUALITY MONITORING WORKSHOP

EXECUTIVE SUMMARY

The Cooperative Monitoring Center (CMC) promotes collaborations among scientists and researchers in several regions of the world as a means of achieving common regional security objectives. To promote cooperation in South Asia on environmental research, an international working group made up of participants from Bangladesh, India, Nepal, Pakistan, and the United States convened at the Yak & Yeti Hotel in Kathmandu, Nepal, from February 17-23, 2002. The workshop was held to further develop the South Asia Transboundary Water Quality Monitoring (SATWQM) project. The project is sponsored in part by the CMC located at Sandia National Laboratories in Albuquerque, New Mexico through funding provided by the U.S. Department of State Regional Environmental Affairs Office, American Embassy, Kathmandu, Nepal, and the National Nuclear Security Administration's (NNSA) Office of Nonproliferation and National Security. This report summarizes the SATWQM project, the workshop objectives, process and results

The principal idea underlying the workshop theme is that cooperation to ensure a sustainable environment can improve relations between countries. Environmental cooperation serves as a Confidence and Security Building Measure (CSBM) when the level of hostility and mistrust between parties (such as India and Pakistan) precludes the possibility of cooperation in more sensitive military-related areas. The potential for armed conflict can increase over disputes along territorial borders involving the contested ownership of resources or access to the resources, such as agricultural land, forest, water, and fish stocks. These disputes could be exacerbated by the degradation and depletion of the contested resources. Along with the benefits of more sustainable uses of natural resources, environmental cooperation among countries also has several indirect, security-related benefits. Environmental cooperation increases dialogue between policy-makers and scientists that can be maintained even when talks on other more sensitive subjects are suspended. Environmental cooperation also creates an information-sharing infrastructure that can be expanded incrementally to include sensitive security and arms control subjects.

The workshop brought together regional partners as well as US government personnel from the American Embassy, and Sandia National Laboratories. The group included six organizations that will work actively with the CMC to gather and share water quality data from locations in South Asia. These six organizations represent three pairs of transboundary partners (i.e., country pairs) located in the border regions of Bangladesh-India, Nepal-India, and Pakistan-India. The workshop participants also included several regional and national government and non-government organizations that are currently involved in project-supporting roles, and that may play a more active role in the future. In addition to the participants attending the workshop, there are several organizations that have indicated an interest in being on the project mailing list and receiving project information and data.

The long-term interests of the participants are to develop systems for sharing regional environmental information as a means of building confidence and improving relations among

South Asian countries. The more immediate interests of the group are focused on activities that foster regional sharing of water quality data in the Ganges and Indus River basins. Issues of concern to the SATWQM network include studying the impacts from untreated sewage and industrial effluents, agricultural run-off, salinity increases in fresh waters, the siltation and shifting of river channels, and the environmental degradation of critical habitats such as wetlands, protected forests, and endangered aquatic species conservation areas.

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From the workshop deliberations several water quality issues were identified that helped define the problems requiring cross-border cooperation and study. These issues are discussed below.

A fundamental issue is the uncertainty and sparseness of data on the quality of water flowing across a border, which in turn breeds suspicion and mistrust. For example, the Pakistani partners attested to the fact that in their border regions, there is a widespread assumption and fear that India sends contaminated water across the border into Pakistan. The monitoring and data sharing aspect of the SATWQM project should provide a unique means to assess such assumptions.

Other issues identified during the workshop are as follows:

- National river water quality monitoring programs are not equally well developed in each country – however, in all cases they tend not to focus on border regions, concentrating their efforts instead on major urban and industrial centers that tend to be further away from international borders. Understanding of an entire watershed, however, is required to be able to predict the impacts of anthropogenic activities – and this necessitates that a regional data sharing process be implemented.
- The effectiveness of municipal wastewater treatment plants is in doubt, as they often are unable to operate because of a lack of electrical power, and most urban centers discharge untreated effluents into rivers.
- The natural attenuation of pollution downstream from urban centers in rivers needs better characterization, especially as the rivers continue to sustain impacts from agricultural and other runoff even in the more rural areas.
- In low flow seasons, the pollution absorbing capacity of rivers is dramatically reduced, but may not always be well characterized.
- The sustainability of ecosystems, such as wetlands, and the conservation of habitats of endangered aquatic species needs to be studied, and in some instances such areas are located on both sides of an international border.
- The sustainability of agricultural practices, such as irrigating desert soils, and the health impacts of using municipal wastewater for irrigation need to be studied.

From discussions of these identified issues, two initial focal areas of study for the SATWQM project emerged:

- Assessing the impact of untreated municipal wastes and/or industrial pollution on rivers in border regions, especially in the low flow seasons.
- Assessing the downstream attenuation of urban pollution, and the impacts of agricultural runoff in rural areas, especially in the low flow seasons.

In many cases, the workshop participants recognized that a downstream country is apt to blame the upstream country for sending polluted water across the borders. However, more detailed studies often establish that the receiving country may be just as culpable in adding pollution loads to the river, and that the water being received may not always be as polluted as popularly believed.

All the Transboundary Data Collection Partners have been provided identical equipment and training to collect water quality data: a Hydrolab MiniSonde for measuring basic in-situ physical parameters, a Jal-Tara water testing kit to do semi-quantitative analyses of fourteen physical and chemical parameters, a Secchi disk for turbidity measurement, a Global Positioning System unit, and a digital camera. A project Sampling and Analysis Plan has been prepared that will ensure that consistent methods are used by all partners. This plan will help the partners collect reliable, accurate, representative and timely data.

The water quality parameters to be monitored include:

- pH
- Temperature
- Conductivity
- Salinity
- Dissolved Oxygen
- Additional analyses using field test kits – e.g. nitrates, iron, hardness, bacteria, benthic organism surveys.

The assessment of river water quality can help to identify potential problems before they give rise to serious adverse health effects. There will be significant benefit to each country involved in understanding the sources of possible contamination and in establishing appropriate monitoring programs. The transboundary nature of the SATWQM project will allow the assessment of river water quality to include entire river basins, and not simply within a country's political boundaries.

The SATWQM project database being created is unique in its transboundary and regional focus, and is, therefore, likely to become an important part of other current or future South Asian water resources studies. Although presently limited in scope to a few key indicator parameters, the proposed studies can potentially complement the use of computer models that predict flow and transport. Information between sampled locations can then be inferred from such models with greater validity. In addition, the use of decision support systems can assist in the sustainable management of resources and the environment.

The monitoring studies that have been initiated in this project are a small step towards large-scale and well-coordinated regional monitoring programs that are needed to fully understand the

complex watersheds of South Asia. In the future, in each of the study areas, a larger set of hydrologic parameters will need to be monitored on a frequent basis. The specific monitoring that will be needed within each of the selected areas will be determined on the basis of the physical layout of the basin, the objectives of the study within that area, and on the availability of instrumentation within the basin. With the establishment of large-scale monitoring efforts, the periodic observations made will be able to detect the impact of human activities and natural processes simultaneously in different locations across national boundaries.

The main purpose of the SATWQM project network is to demonstrate technology and data sharing capabilities. Therefore, the focus of the project is on promoting a regional water-related data sharing process, and not simply on the data itself. Through the transfer of appropriate technologies and the training of regional participants, it is hoped that the network will be expanded in subsequent projects by regional entities. By demonstrating the ease and utility of cross-border sharing of data, the modest SATWQM effort described here could be expanded in the future into a much larger scale and government-led effort.

ACKNOWLEDGEMENTS

The organizers gratefully acknowledge support of the workshop from the U.S. Department of Energy (DOE) National Nuclear Security Administration's (NNSA) Office of Nonproliferation and National Security. We also thank Mr. Michael DeTar and Mr. Jay Pal Shrestha of the Regional Environmental Affairs Office American Embassy in Kathmandu, Nepal, for financial and technical support in arranging the workshop. Special thanks go to Mr. Howard Passell of the CMC for assistance in shipment of needed water quality equipment, and creating a detailed manual for equipment calibration and maintenance. Ms. Martha Haines and Ms. Marla Clary provided invaluable help in making the logistical arrangements for the workshop.

NOMENCLATURE

AID	U.S. Agency for International Development
BDOE	Bangladesh Department of the Environment
BMOEF	Bangladesh Ministry of Environment and Forests
BOD	Biological Oxygen Demand
BUP	Bangladesh Unnayan Parishad
CMC	Cooperative Monitoring Center
COD	Chemical Oxygen Demand
CSBM	Confidence and Security Building Measure
DO	Dissolved Oxygen
DOE	U.S. Department of Energy
ENPHO	Environment and Public Health Organization
ICIMOD	International Center for Integrated Mountain Development
IUCN	World Conservation Union
NGO	Non-Governmental Organization
NNSA	National Nuclear Security Administration
NWCF	Nepal Water Conservation Foundation
SATWQM	South Asia Transboundary Water Quality Monitoring
WWF	World Wide Fund for Nature

1.0 INTRODUCTION

The South Asia Transboundary Water Quality Monitoring (SATWQM) project promotes regional environmental cooperation in South Asia[1] through technical collaborations in water quality research among participants from Bangladesh, India, Nepal, Pakistan, and the United States. The SATWQM network is composed of research institutions, universities, and non-governmental organizations.

In February 2002, we conducted a very successful workshop in Kathmandu, Nepal, that brought together the principal partners who are participating in the project. (Figure 1 presents a photograph of the workshop participants.) The partners provided additional information on their organizations and perspectives on their water quality issues, received training on monitoring equipment, and finalized input to a Sampling and Analysis Plan for the consistent collection of water quality data on their respective portions of the transboundary rivers.

This report summarizes the SATWQM project, the workshop objectives, process and results.

Figure 1: Photograph of the Workshop Participants (Appendix A Provides a List of Names)

Specifically, through the workshop, we jointly developed an active and unique cooperative monitoring project on water quality issues that affect transboundary tributaries of the Indus and Ganges River basins. Members of the SATWQM network collect water quality data on these rivers in the border regions of Pakistan-India (on the Ravi River), Nepal-India (on the Bagmati

[1] South Asia is defined in this report as Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

and Narayani Rivers), and Bangladesh-India (on the Ganges River). The data are shared over the Internet through a project web site (http://sa-env.cmc.sandia.gov/).

1.1 Context

The Cooperative Monitoring Center (CMC) is located at Sandia National Laboratories in Albuquerque, New Mexico, USA and is primarily sponsored by the U.S. Department of Energy (DOE). The CMC promotes collaborations among scientists and researchers as a means of helping secure a peaceful world through technology. In order to promote regional cooperation on environmental research, we have initiated a project to measure and monitor environmental parameters. We are conducting this project on environmental topics as part of our South Asia regional program because sustainable environmental conditions support stable economic and social conditions. This stability can improve relations between countries, reduce tensions, and thereby reduce the risk of conflict.

The first step of this project was initiated in June 1998 when regional experts in water resources and policy from India, Nepal, and Bangladesh met at the CMC to discuss potential project ideas. Two of the topics of primary interest were water resources in the Ganges-Brahmaputra-Meghna River basins and sustainability of the Sunderbans mangrove forest area. Additional topics included groundwater resources and quality, especially arsenic contamination. After that workshop, the Indus River basin and coastal resources were included as additional topics appropriate for cooperative monitoring projects.

In September 1999, the CMC hosted a water resources workshop in Kathmandu, Nepal, jointly with the American Embassy in Kathmandu. The main purpose of the workshop was to begin an experiment to investigate the process of sharing water quality monitoring information between regional parties from select, non-sensitive locations to promote regional cooperation on water quality issues common to the region. Partners from this Phase 1 project include participants from Bangladesh, India, Nepal, Pakistan and Sri Lanka. Water quality measurements of salinity, temperature, conductivity, and pH were measured using commercially available hand-held water monitoring equipment. The data gathered were shared among the parties via the CMC over the Internet.

Currently, with complementary funding from the US Department of State Regional Environmental Affairs Office, we have begun Phase 2 of the project in which we focus on active monitoring of water quality parameters which are of importance to regional transboundary river issues. Specifically, we are striving to develop a cooperative monitoring project on water quality issues that affect transboundary tributaries to the Indus and Ganges Rivers. In February and March of 2001 we traveled to the region seeking a better understanding of these issues and seeking potential partners interested in developing and participating in a cooperative transboundary project. All of the organizations we met responded positively to the project. As the next step, we conducted the SATWQM workshop in Kathmandu, Nepal in February 2002 to bring together the partners who are now actively participating in the project.

The CMC and Sandia National Laboratories have a broad range of significant technical expertise that can be applied to cooperative environmental monitoring projects including high-resolution remote sensing, data transmission and security, computer modeling, data management and

decision support tools, and the infrastructure to support cooperative monitoring efforts. The CMC works with other entities including the US Geological Survey, Environmental Protection Agency, Bureau of Reclamation, numerous universities, and local and state governments.

Working together with our South Asian and American colleagues, we believe this project contributes both to environmental research and to increased cooperation and confidence building among scientists in South Asia.

The principal idea underlying the workshop theme is that cooperation to ensure a sustainable environment can improve relations between countries. Environmental cooperation serves as a Confidence and Security Building Measure (CSBM) when the level of hostility and mistrust between parties (such as India and Pakistan) precludes the possibility of cooperation in more sensitive military-related areas. The potential for armed conflict increases over disputes along territorial borders involving the contested ownership of resources or access to the resources, such as agricultural land, forest, water, and fish stocks. These disputes could be exacerbated by the degradation and depletion of the contested resources.

Along with the benefits of more sustainable uses of natural resources, environmental cooperation among countries also has several indirect, security-related benefits. Environmental cooperation increases dialogue between policy-makers and scientists that can be maintained even when talks on other more sensitive subjects are suspended. Environmental cooperation also creates an information-sharing infrastructure that can be expanded incrementally to include sensitive security and arms control subjects.

1.2 Water Quality Issues in South Asia and Benefits of Transboundary Monitoring

The Second World Water Forum, the Hague, 17-22 March 2000, adopted a document – VISION 21 – that has the ultimate goal "to provide everyone with a safe water supply and adequate sanitation services and hygiene by 2025". However, globally, "nearly 1.1 billion people still remain without access to improved drinking water services and about 2.4 billion have no access to any form of improved sanitation facilities. As a consequence, 2.2 million people in developing countries, most of them children, die every year from diseases associated with lack of safe drinking water, inadequate sanitation and poor hygiene." [2]

In South Asia,[3] approximately 30% of the population (~400,000,000 people) does not have access to improved drinking water supplies, and approximately 50% of the population (~600,000,000 people) does not have sanitation coverage. In rural areas, the situation is even worse. For example, in the rural areas of South Asia almost 70% of the population has no improved sanitation, compared with 22% in urban areas.

In South Asia, along with agricultural and industrial uses, the water of every river system is used for primary human contact and drinking water – even urban storm water drains that often carry industrial and municipal effluents are used for swimming and the hand washing of clothes. There

[2] Global Water Supply and Sanitation Assessment 2000 Report; The Global Assessment 2000 report was produced in partnership with WHO and the Water Supply and Sanitation Collaborative Council.
[3] Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

is a great need, therefore, to monitor the water quality of rivers and ensure that the water quality meets the actual and designated uses.

The purpose of the South Asia Transboundary Water Quality Monitoring (SATWQM) project is to create a common shared database on transboundary river water quality in South Asia. The SATWQM project does not attempt to duplicate existing national programs, nor does it seek to supplant multilateral environmental data sharing programs of the United Nations (UN) or other organizations. Rather, the SATWQM project is designed to be a demonstration experiment that will strengthen the sharing of water quality data among non-governmental organizations in several South Asian countries, thereby creating a complementary technical infrastructure that also can eventually be adopted by governmental entities. The SATWQM project, therefore, is the catalyst that will demonstrate and initiate the various water quality data sharing projects many South Asian countries have possibly envisioned but not yet started implementing. The SATWQM project will also enhance the technological capabilities of each country's national river water quality monitoring programs, increasing the sophistication of the technology used and improving the quality and comparability of the data collected.

The assessment of river water quality can help to identify potential problems before they give rise to serious adverse health effects. There will be significant benefit to each country involved in understanding the sources of possible contamination and in establishing appropriate monitoring programs. The transboundary nature of the SATWQM project allows the assessment of river water quality to include entire river basins, and not simply within a country's political boundaries.

On the Pakistan-India border, for instance, the Hudiara drain is an urban storm water drain that originates in Batala, India, travels across the border into Pakistan and then empties into the Ravi River near Lahore. In the summer months, prior to the monsoon season, this drain principally carries industrial and municipal wastewater effluents discharged from within India and Pakistan. However, the contaminated waters of the drain are used by nearby residents for drinking, swimming, agriculture, and raising livestock. For the first time, through the SATWQM project, partners in Amritsar, India and Lahore, Pakistan are working cooperatively to undertake a simultaneous survey of the water quality in this drain upstream and downstream of the border. These data will allow comprehensive water quality assessments to be made and management plans to be developed.

1.3 The Goals of the SATWQM Project

The long-term interests of the project participants are to develop systems for sharing regional environmental information as a means of building confidence and improving relations among South Asian countries. The more immediate interests of the group are focused on activities that foster regional sharing of water quality data in the Ganges and Indus River basins. Issues of concern to the SATWQM network include studying the impacts from untreated sewage and industrial effluents, agricultural run-off, salinity increases in fresh waters, siltation and the shifting of river channels, and the environmental degradation of critical habitats such as wetlands, protected forests, and endangered aquatic species conservation areas.

The SATWQM project is a unique regional network in South Asia that is continuing to progress despite the strained relations in the region, including between India and Pakistan. Currently,[4] India and Pakistan have their armies massed at their borders in a state of high alert, all cross-border transport links between the two countries are cut, and almost all diplomatic relations are severed. However, despite this situation, members of the SATWQM network – including partners from India and Pakistan – continue to actively engage in cooperative field and analytical project activities.

The SATWQM network is now poised to expand its membership, increase the number of sampling sites and parameters being monitored, consolidate its relationship with national government river water quality monitoring programs,[5] and begin a transition from a US-hosted initiative to one managed by a regional organization.[6]

Figure 2 depicts the geographic areas of relevance to the project.

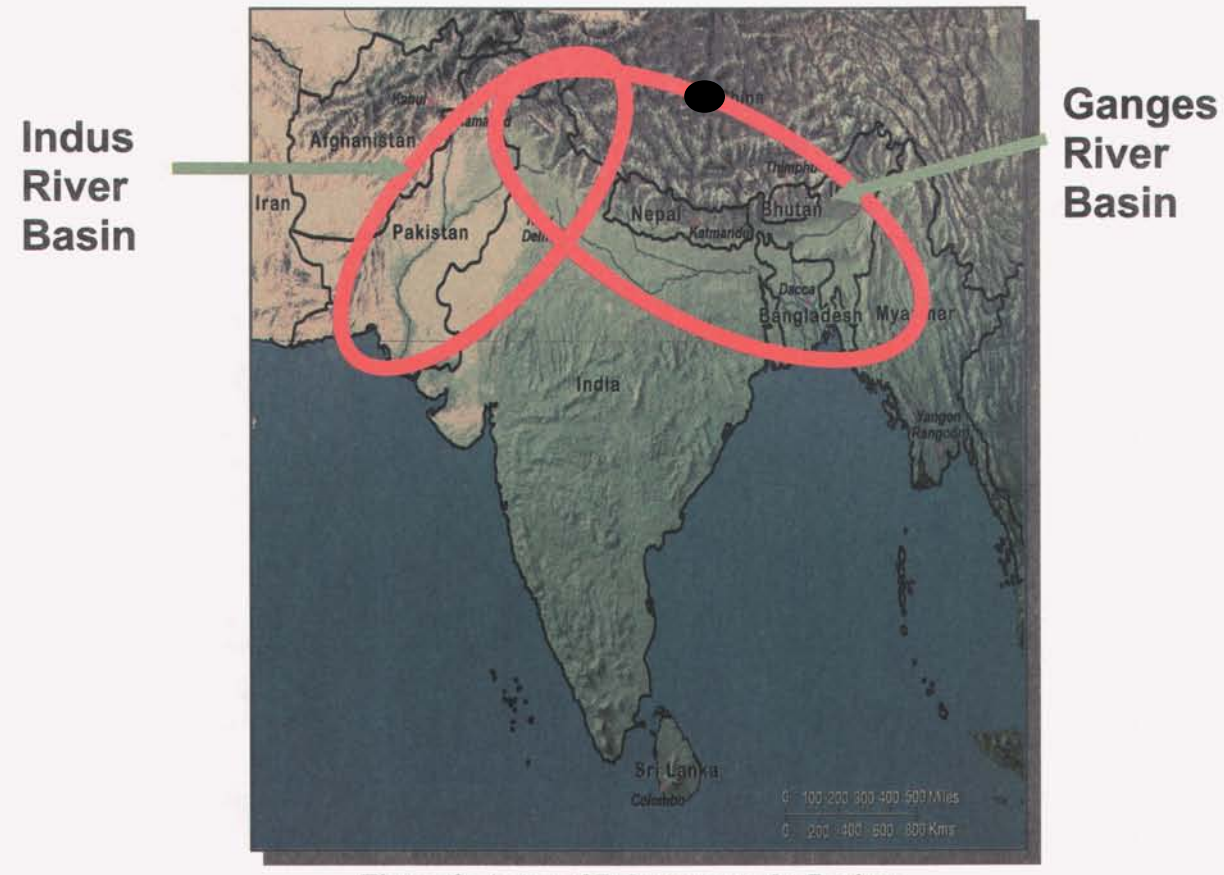


Figure 2: Areas of Relevance to the Project

[4] August 2002.

[5] In a recent meeting with project staff, India's National River Conservation Department of the Ministry of Environment and Forests has expressed interest in sharing water quality data and joining the network; Nepal's Ministry of Hydrology and Meteorology has also expressed interest in sharing data and joining the network.

[6] The International Center for Integrated Mountain Development has indicated an interest in merging the SATWQM structure into a United Nations program on the sharing of river water quality data.

2.0 WORKSHOP OBJECTIVES AND PROCESS

2.1 Objectives and Roles of Partners

The SATWQM project is a modest initiative to promote collaborative interactions between environmental organizations in South Asia through the collection and sharing of water quality data. The project also facilitates linkages among groups that need the water quality data for their own work in the region and help these groups improve their technical capabilities.

The SATWQM project's goal is to bring together a group of partners who are willing to invest their efforts into the success of this transboundary network to reap the rewards of a larger collaboration. Generally, the partners are already actively engaged in water-quality data collection activities, and we expect that their interest is strong enough that they will invest the incremental effort to collect a little additional SATWQM data as part of their on-going activities.

The workshop brought together regional partners as well as US government personnel from the American Embassy, and Sandia National Laboratories. The group included six organizations that will work actively with the CMC to gather and share water quality data from locations in South Asia. These six organizations represent three pairs of transboundary partners (i.e., country pairs) located in the border regions of Bangladesh-India, Nepal-India, and Pakistan-India. The workshop participants also included several regional and national government and non-government organizations that are currently involved in project supporting roles, and that may play a more active role in the future. In addition to the participants attending the workshop, there are several organizations that have indicated an interest in being on the project mailing list and receiving project information and data.

The individuals actively participating in the project are listed in Table 1 (in alphabetical order of the three country pairs). Under a combination of contractual and voluntary arrangements, each partner will collect water quality data using instrumentation provided by the CMC. These partners are designated "Transboundary Data Collection Partners" to distinguish them from other partners playing supporting roles, whom we have designated as "Supporting Partners."

The workshop focused on these five objectives: 1) a deepened understanding of the partner organizations involved; 2) garnering the support of additional regional and national government and non-government organizations in South Asia involved in river water quality monitoring; 3) identification of sites within the region at which water quality data are to be collected; 4) instituting a data and information collection and sharing process; and, 5) training of partners in the use of water quality monitoring equipment.

Table 1: List of Transboundary Data Collection Partners

Country	Organization	Points of Contact
Bangladesh-India	Bangladesh Unnayan Parishad, Dhaka, Bangladesh (NGO)	Mr. Khalilur Rahman Prof. K.B.S. Rasheed
	Center for Environment and Development, Kolkata, India (NGO)	Dr. A.K. Ghosh, Mr. Jyotirmoy Mukherjee

Nepal-India	Environment and Public Health Organization, Kathmandu, Nepal (NGO)	Dr. Roshan Raj Shrestha, Dr. N. Upadhyaya
	Environmental Biology Laboratory, Patna University, Patna, India (Academic)	Dr. Ravindra .K. Sinha, Dr. K. Prasad
Pakistan-India	World Wide Fund for Nature- Pakistan, Lahore, Pakistan (NGO)	Mr. Hammad Naqi Khan, Dr. Masil Khan
	Aquatic Biology Laboratory, Guru Nanak Dev University, Amritsar, India (Academic)	Dr. Anish Dua
USA	Cooperative Monitoring Center, Albuquerque (Government and Industry)	Dr. J. David Betsill Dr. Gaurav Rajen

Other participants in the workshop were (in alphabetical order):[7]

Ms. T. Anuradha, Development Alternatives (NGO)
Dr. Keshari Bajracharya, Nepal Ministry of Hydrology and Meteorology (Government)
Mr. Roy Boerschke, World Bank/ Canadian International Development Agency (Multilateral financial institution/ Government)
Dr. Gabriel Campbell, International Center for Integrated Mountain Development (ICIMOD) (NGO)
Mr. Anthony Carvalho, US AID, Kathmandu, Nepal (Government)
Mr. Robin Lal Chitraka, Nepal Drainage and Sanitation Board (Government)
Mr. Michael DeTar, Regional Environmental Affairs Office, American Embassy, Kathmandu, Nepal (Government)
Mr. Kanchan Dixit, Nepal Water Conservation Foundation (NGO)
Mr. Ajaya Dixit, Nepal Water Conservation Foundation (NGO)
Dr. Dipak Gyawali, Nepal Water Conservation Foundation (NGO)
Col. (Ret.) V. Katju, Development Alternatives (NGO)
Mr. Fred Luetters, Cooperative Monitoring Center, Albuquerque, USA (Government)
Dr. Marcus Moench, Institute for Sustainable Development (NGO)
Dr. Dhruba Pant, International Water Management Institute (NGO)
Mr. Bikash Pandey, Winrock International (NGO)
Dr. Bandana Kayastha Pradhan, ICIMOD (NGO)
Dr. Asad Qureshi, International Water Management Institute (NGO)
Mr. Suresh Raj Ranjitkar, World Bank (Multilateral financial institution)
Mrt. Brij Sahni, Winrock International (NGO)
Dr. Usha Sharma, World Conservation Union (IUCN) (NGO)
Mr. Jay Pal Shrestha, Regional Environmental Affairs Office, American Embassy, Kathmandu, Nepal (Government)
Ms. Mandira Shrestha, ICIMOD (NGO)
Mr. Yug Tarmakar, Greenstar Foundation, Kathmandu, Nepal (NGO).

2.1.1 The Types of Partners

The participants can be broadly grouped into Supporting Partners and Transboundary Data Collection Partners. There were also some informal participants at the workshop from academia, government programs, and consulting businesses. Some of the informal participants are likely to

[7] A few of these participants did not attend the entire workshop.

be increasingly involved in the project as it develops. Others may remain essentially in an observer status, offering assistance through coordination and advice.

The membership in the various groups of partners is likely to keep evolving as the project matures. Transitions will occur between the various groups and new members are likely to join these somewhat informal groupings.

2.1.2 The Roles of Supporting Partners

All of the partners perform the roles that the Supporting Partners will play; the other partners perform additional tasks. Any partners from Phase 1 of the project have essentially become Supporting Partners to Phase 2 of the project. They may infrequently supplement the data they have already sent during Phase 1. The roles of Supporting Partners are to:

- Share relevant archival data from other water quality monitoring projects on transboundary rivers using the SATWQM project web site
- Disseminate project data and information
- Provide insight and guidance to ensure project success and sustainability.

2.1.3 The Role of Transboundary Data Collection Partners

In addition to the roles of Supporting Partners, the Transboundary Data Collection Partners perform these additional tasks:

- Provide the in-kind services needed to collect the SATWQM project data
- Use the equipment supplied to the project as a part of their ongoing and independently planned studies
- Share existing and SATWQM data collected using the project web site.

2.1.4 The Role of the CMC

The CMC is the main force behind the project, and, therefore, has some unique tasks not shared by other Partners:

- Act as the catalyst for the SATWQM project through the sponsorship and guidance of the U.S. Department of State's Regional Environmental Affairs Office, and the US Department of Energy.
- Supply reliable and identical equipment, procedures, and training to SATWQM partners to collectively create a larger set of accurate, reliable, and comparable data for all partners to share.
- Create mechanisms to access and use the data via the project web site.
- Host the project workshop.
- Prepare reports.

2.2 Workshop Structure

A series of sessions were planned over the first three days of the workshop to meet the objectives and clarify the roles of all partners. The sessions included:

- Introductions to the various US government agencies and programs involved, similar cooperative water quality monitoring projects in other regions, and a history of Phase 1 of the SATWQM project.
- Supporting Partner presentations regarding their organizations, and previous work related to river water quality monitoring.
- Short special presentations by invited organizations on water policy, and renewable energy issues.
- Transboundary Data Collection Partner presentations, regarding their organizations, previous work related to river water quality monitoring, and proposed SATWQM sampling locations.
- Finalizing the draft Sampling and Analysis Plan.
- Future joint proposals and funding issues.

The next two days of the workshop were focused on training in water sampling instrumentation and a field exercise.

2.3 Workshop Process

The workshop was conducted over six days. The workshop and project concept has been strongly endorsed by the US State Department. The US Ambassador to Nepal, Michael Malinowski, provided the opening workshop address (Figure 3). Ambassador Malinowski also hosted a reception at his residence for the workshop participants where they were able to network with regional diplomats, government officials, and other interested persons.

On the first day, the workshop sessions began with an introduction by Mr. Michael DeTar, of the Regional Environmental Affairs Office, American Embassy, Kathmandu, Nepal. Mr. Michael DeTar manages the Regional Environmental Affairs Office (one of the main sponsors of the SATWQM project); he presented an overview of the various regional environmental projects of his office. Next, Mr. Frederick O. Luetters, Manager of the International Security Initiatives Department at the CMC, presented an overview of Sandia National Laboratories and the CMC. Then, Dr. J. David Betsill, South Asia Environmental Projects

Figure 3: Ambassador Michael Malinowski Inaugurating the Workshop

Manager, who leads the project for the CMC, presented information on previous cooperative water quality monitoring projects undertaken by the CMC, such as in Central Asia and the Middle East. Dr. Gaurav Rajen, a consultant to the CMC from the University of New Mexico, provided a history of Phase 1 of the SATWQM project. Finally, Dr. Betsill discussed the current status and expectations of Phase 2 of the SATWQM project. Supporting Partners made presentations during the remainder of the first day. The day ended with three special presentations by invited lecturers on water policy and renewable energy uses for water treatment and Internet access in rural areas.

The Transboundary Data Collection Partners made detailed presentations on the second day of the workshop. The country pairs who are coordinating their data collection activities were formed into three groups to make their presentations:

- Nepal-India
- Pakistan-India
- Bangladesh-India.

The third day of the workshop involved finalizing the draft Sampling and Analysis Plan, and discussing future joint proposals and funding issues.

On the fourth day, Dr. David Betsill and Dr. Gaurav Rajen demonstrated the water quality instrumentation that is being provided to each project partner. Section 3.4 describes this equipment in more detail. Figure 4 shows some of the workshop participants observing a demonstration of a Hydrolab MiniSonde that simultaneously measures in-situ, pH, temperature, dissolved oxygen, conductivity, and salinity. The instrument has a digital logging capability with the direct download of data to a computer. A field kit for chemical analyses of water samples is also being provided to the project partners. This kit is called "Jal-Tara" and is manufactured by Development Alternatives (DA), one of the Supporting Partners from India. Ms. T. Anuradha of DA provided a detailed description and demonstration. Figure 5 shows Ms. Anuradha demonstrating the Jal-Tara kit. Dr. Gaurav Rajen then demonstrated a prototype Internet site developed for the project. This site will serve as a home to project data gathered and a link to regional web sites on the environment. The web site is further described in Section 3.5. The data format and data transmission issues were also addressed, as well as the direct download of Hydrolab data to a computer.

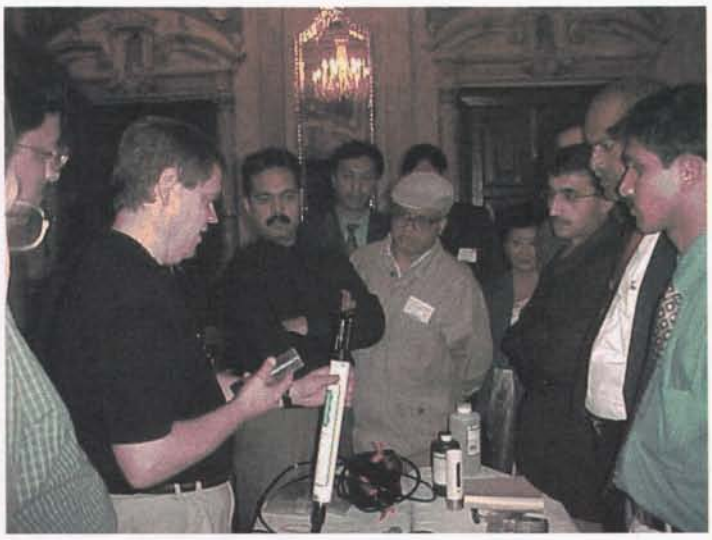


Figure 4: Workshop participants observing a demonstration of the Hydrolab Minisonde

On the final day, the workshop continued with a field exercise and hands-on training with the water quality instrumentation – the Hydrolab Minisonde, the GPS unit, the Secchi disk, the digital camera and the Jal-Tara kit. A planned field trip to the Bagmati River was cancelled because of security concerns over a political demonstration and the threat of Maoists' unrest. The sampling and equipment training instead took place at a pond located within the grounds of the Yak & Yeti Hotel where the workshop was held.

The workshop concluded by discussing resource constraints and funding needs of all partners, the next steps in implementing the project, and a wrap-up session in which action items were outlined and discussed.

Figure 5: Ms. T. Anuradha of Development Alternatives demonstrating the Jal-Tara kit

Figure 6: Field training exercise at a small pond on the Yak & Yeti hotel grounds

3.0 WORKSHOP RESULTS

This section summarizes the major products of the workshop: 1) a deepened understanding of the partner organizations involved; 2) garnering the support of additional regional and national government and non-government organizations in South Asia involved in river water quality monitoring; 3) identification of sites within the region at which data is to be collected; 4) instituting a data and information collection and sharing process; and, 5) training of partners in the use of water quality monitoring equipment.

3.1 Understanding the River Basins, and the Organizations Involved

Each Transboundary Data Collection Partner provided information on the river basin they will be sampling, as well as on past water quality monitoring activities. In the future, similar SATWQM reports will be generated on a transboundary basis. Due t their large size, detailed descriptions of the organizations involved and the information they provided are omitted in this summary report on the SATWQM workshop. This information is to be presented in a subsequent more detailed report.

There were two kinds of organizations represented at the workshop. The first represent the Transboundary Data Collection Partners (see Table 1). These are organizations that will collect and share water quality data in collaboration with the CMC. The second set represents Supporting Partners. These are regional and country-specific organizations that are committed to supporting and/or progressively becoming more involved in the project, including sharing relevant archival data, disseminating project data and information, and providing insight and guidance to ensure project success and sustainability. This second set also includes all of the Phase 1 partners, some of who collected data specifically for Phase 1 of the SATWQM project. The Phase 1 partners have been described in the Phase 1 report (Rajen, Betsill and Biringer, 2001).

3.2 Identification of Sites

A significant portion of the workshop was dedicated to describing country-specific and transboundary issues, determining where the Transboundary Data Collection Partners would sample, and how they would coordinate their activities.

From the workshop deliberations the following water quality issues emerged and helped define the problem area where cross-border study could be beneficial:

- National river water quality monitoring programs are not equally well developed in each country – however, in all cases they tend not to focus on border regions, concentrating their efforts instead on major urban and industrial centers that tend to be further away from international borders.
- The uncertainty and sparseness of data regarding the quality of water flowing across a border breeds suspicion and mistrust – for example, the Pakistani partners attested to the fact that in their border regions, there is a widespread assumption and fear that India sends contaminated water across the border into Pakistan.

- The effectiveness of municipal wastewater treatment plants is in doubt, as they often are unable to operate because of a lack of electrical power, and most urban centers discharge untreated effluents into rivers.
- The natural attenuation of pollution downstream from urban centers and the impacts of agricultural runoff in rural areas need better characterization.
- In low flow seasons, the pollution absorbing capacity of rivers is dramatically reduced, but may not always be well characterized.
- The sustainability of ecosystems, such as wetlands, and the conservation of habitats of endangered aquatic species needs to be studied, and in some instances such areas are located on both sides of an international border.
- The sustainability of agricultural practices, such as irrigating desert soils, and the health impacts of using municipal wastewater for irrigation need to be studied.

From discussions of these identified issues, two initial areas of study for the SATWQM project emerged:

- Assessing the impact of untreated municipal wastes and/or industrial pollution on rivers in border regions, especially in the low flow seasons.
- Assessing the downstream attenuation of urban pollution, and the impacts of agricultural runoff in rural areas.

In many cases, the workshop participants recognized that a downstream country is apt to blame the upstream country for sending polluted water across the borders. However, more detailed studies often establish that the receiving country may be just as culpable in adding pollution loads to the river, and the water being received may not always be as polluted as popularly believed. The Hudiara drain study by the WWF-Pakistan is a good example of one such case.

The sampling locations proposed by some of the partners were revised to better reflect the concerns of their transboundary partner – that is, each upstream partner selected sites that were located on the same stem of the river their downstream partner in the neighboring country was also interested in. The major changes made to the preliminary set of sites selected by the partners were also to lower the number of sites, select sites closer to the border regions and on actual cross-border stems of rivers, and limit sites to those requiring low transportation and logistics costs.

The final outcomes of these deliberations and agreements are described in Figure 7 and in Table 2.

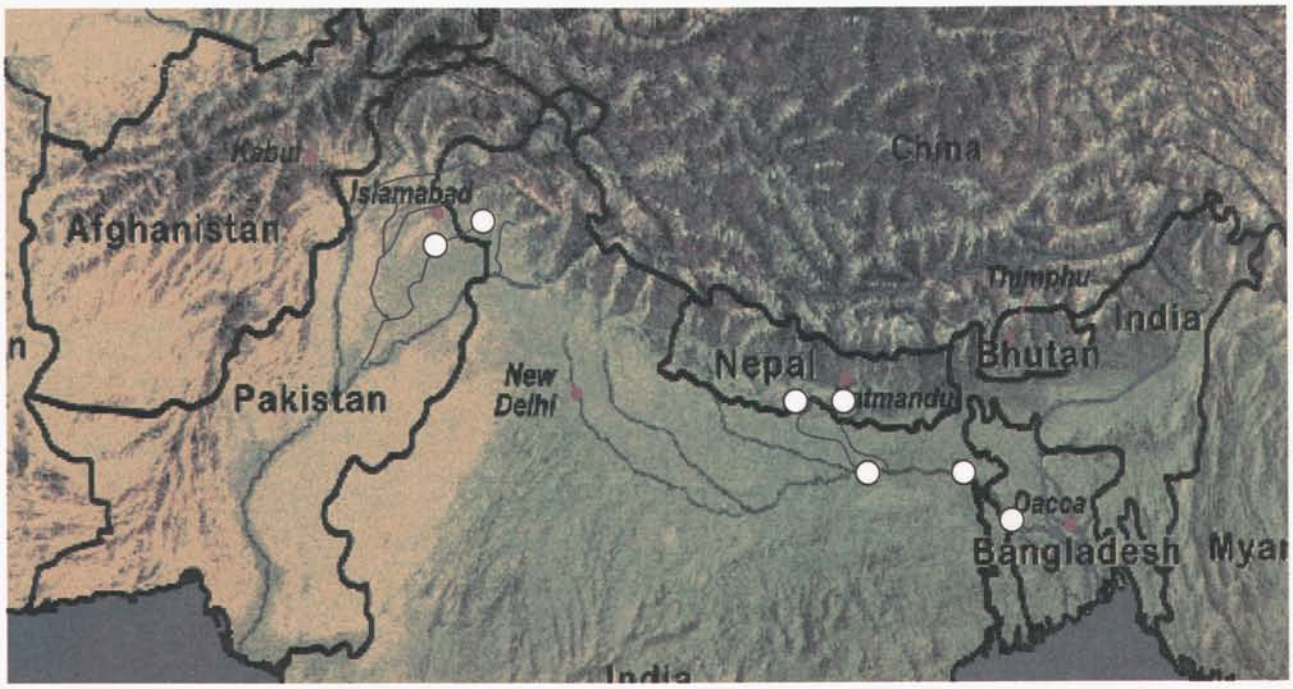


Figure 7: Approximate geographical locations of selected sampling sites (identified by the white circles). Note that each circle may represent several sampling sites in close proximity to each other, such as upstream and downstream of a city or industrial facility.

Table 2: Sampling Locations Selected by the SATWQM Partners

Country-Pair	Partner	River	Location	Additional description
Bangladesh-India	BUP	Padma/ Ganges	Godagari	Close to the border
			Rajshahi	A divisional city is located at the left bank
			Paksey/Hardinge Bridge	In an area impacted by urban effluents
	CED	Ganges	Dhulian	Downstream of the Farakka Barrage
			Lalgola	Location close to the border
Nepal-India	ENPHO	Bagmati	Sundarijal	Unpolluted headwater region
			Sundarighat	Downstream of Kathmandu
			Gaur	Located near the border
		Narayani	Devghat	Unpolluted location, upstream of the city of Narayanghat
			Meghauli	Location along the Narayani River after it has received urban and industrial effluents
			Tribeni	Location close to the border
	EBL-Patna	Narayani/ Gandak	Patna	Near the confluence of the Gandak River with the Ganges River
		Ganga	Locations along Ganga	Locations that are routinely monitored as a part of a national program
Pakistan-India	WWF-P	Ravi	Upstream of Lahore	Upstream of major drains, relatively unpolluted
			Downstream of Lahore	Downstream of all major drains and effluent outfalls
	ABL-Amritsar	Ravi	Madhopur	Downstream of pollution sources
			Narot Jaimal Singh	Close to India-Pakistan border
			Harike wetlands	A wetland of international importance designated in the Ramsar Convention

3.3 Data and Information Collection and Sharing

For consistency, a Sampling and Analysis Plan (SAP) has been developed for the project. Each partner will follow environmental sampling guidelines and Standard Operating Procedures (SOP) described in the SAP. The SAP and SOPs help ensure that the project partners collect data that are comparable, consistent, reliable, accurate, and timely. Each partner has also committed to sharing SOPs developed by the appropriate environmental regulatory authorities in their country. Sharing this information will itself create greater transparency. The partners also plan to maintain thorough field notes in bound and numbered record books. Communication of the data collected will be via the project web site using the Internet.

Each party generating data has the responsibility to implement procedures that assure that the parameters measuring data quality are known and documented. These measures are:

- Precision
- Accuracy
- Representativeness
- Comparability
- Completeness.

Each partner is expected to assess and document the level of data quality as sampling situations vary widely and no general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The logbook should preferably be stored in a location that is easily accessible to the project staff and managers.

Communication will be via the Internet and the project web site that has a web-based form into which data are input. These data go directly into a database and are then available for viewing on the project web site.

There are two types of information to be sent:

- Static and quasi-static information sent infrequently. This information, for example, will describe sampling sites in detail.
- Periodic information on a site that is already described, for example, water quality data, will be sent monthly (at a minimum).

3.3.1 Sample Collection Strategies

There are three sample collection strategies that are potentially relevant for the project:

- High-volume filtering systems
- Isokinetic depth and width-integrated sampling
- Grab sampling.

In high-volume filtering systems, typically at each sampling location, up to 1000 liters of water are pumped through a filter; the filter traps suspended sediments for subsequent analysis.

In isokinetic depth and width-integrated sampling, at each sampling location, up to 40 liters of water are collected and mixed from numerous points along the width of the river. The samples may be filtered.

In grab sampling, at each sampling location, up to 5 liters of water are collected from one or a few points on the surface of the river. Samples may be filtered if appropriate.

At the workshop, we concluded that the initial SATWQM Phase 2 sampling strategies should be simple and easy. Therefore, the grab sampling method was selected as the most appropriate. The SAP describes the grab sampling method using unfiltered samples. As the project develops, different sampling strategies may be adopted depending upon the agreement of the partners, available time, and resources. Also, indigenous analytical capabilities in the partners' laboratories and data quality objectives will have important impact on future strategies. Additional funding from other funding sources may be required for sophisticated or extensive analyses.

3.3.2 Water Quality Indicator Parameters to be Measured

Basic physical, chemical, and bacteriological "indicator" parameters are to be measured in the SATWQM project. These are:

- Temperature
- Conductivity
- Total dissolved solids (TDS)
- Salinity
- pH
- Oxidation-reduction potential
- Dissolved oxygen (DO)
- Major dissolved ions
- Fecal coliform presence
- Nutrients.

Brief descriptions of the importance or relevance of these parameters are presented below.

Temperature is an important mediator of chemical reactions in water and an indicator of habitat suitability for aquatic life.

Conductivity is a measure of the ability of an aqueous solution to carry an electric current through ions in the water. Conductivity measures ionic content, which is directly correlated to Total Dissolved Solids, and Salinity (salts). Contaminants can combine with dissolved solids and get transported. Also, water with high salinity is destructive to agricultural lands.

The *pH* is a measure of the balance in water between acidity and alkalinity. It affects chemical solubility and influences chemical speciation. It also affects biological activity.

The *Oxidation-Reduction Potential* (also known as ORP, Redox, Eh), mediates oxidation-reduction reactions in water, and influences the solubility of various chemical species, especially metals.

Dissolved Oxygen (DO) is a critical variable in biological systems and an important indicator of pollution along with nutrients nitrogen and phosphorous.

Dissolved Ions are an important indicator of the suitability of water for drinking, irrigation, and industrial use. For drinking water, the US Environmental Protection Agency has suggested that there be less than 500 mg/L dissolved solids. Dissolved ions in irrigation water may adversely affect the ability of plant roots to take up nutrients.

Levels of *Fecal Coliform* bacteria indicate the likelihood of wastewater and water borne diseases and pathogens.

The *Nutrients* nitrogen and phosphorous are essential for the growth and reproduction of plants and plankton. However, excess nutrients in water may stimulate uncontrolled growth of algae resulting in oxygen levels reduced so much that fish will die. For drinking water, the US EPA has set a limit that the total concentration of nitrates-nitrogen must be less than 10 mg/L. Concentrations higher than this level have alsobeen found to be toxic for babies.

In the future, in each of the study areas, a larger set of hydrologic and chemical parameters may need to be monitored on a more frequent basis. The specific monitoring that will be needed within each of the selected areas will be determined on the basis of the physical layout of the basin, the objectives of the study within that area, the ongoing monitoring programs in the study area conducted by other programs, and on the availability of instrumentation within the basin.

3.4 Project Equipment

The equipment supplied for the project includes the following:

- Hydrolab Minisonde and Data Logger
- Jal-TARA water testing kit
- Secchi Disk for turbidity measurements
- Digital Camera – SONY Mavica FD-75
- Global Positioning Unit – Magellan GPS-315.

This equipment is further described in the companion detailed workshop report, and omitted in this summary.

3.5 Project Web Site

The project web site is designed to:

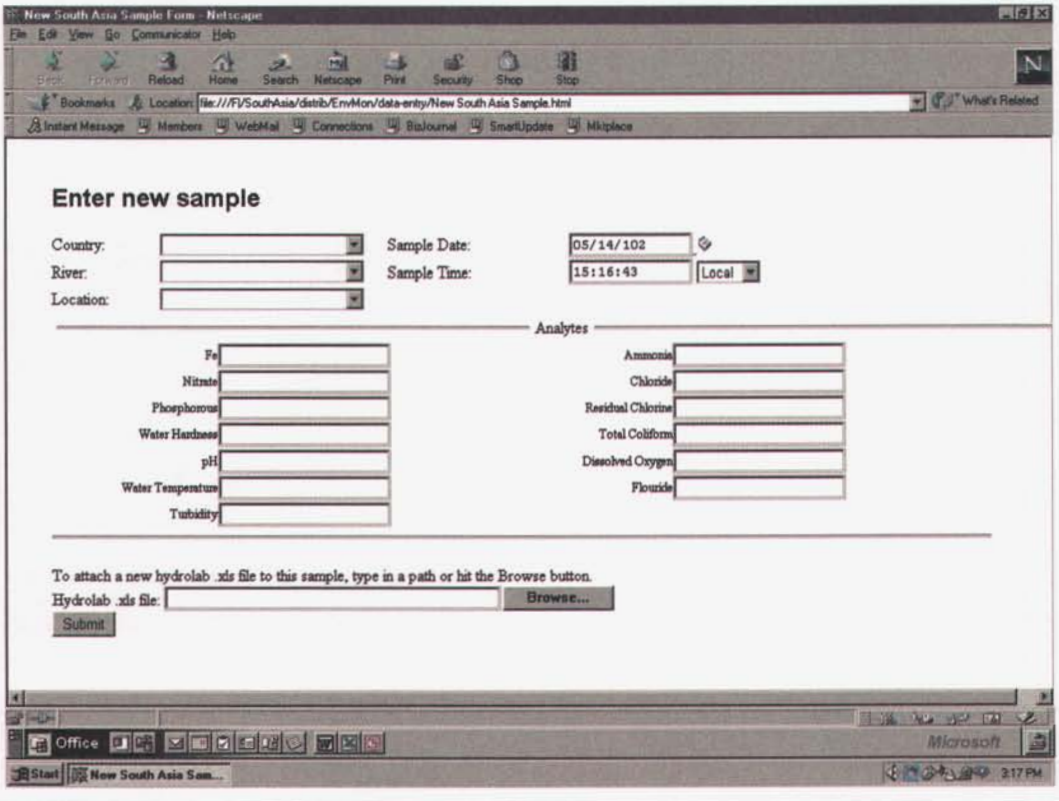
- Provide links to existing data sources
- Present partner information
- Share water quality data generated by partners.

The SATWQM project web site opens with some background text on the project, and a series of hypertext links in a side frame in the form of buttons to click. The more important buttons provide the viewer with the following options:

- Additional information about the Project
- Additional information about the Partners
- Links to the Phase 1project web site, and international, regional and country-specific data sources
- A web-based data entry form, accessible only to project data collection partners
- Project documents
- Information on project workshops.

Other buttons provide language support, a utility to search the site, and acknowledgements. Figure 8 depicts the data entry form that allows the project data collection partners to input water quality data directly into the project database.

Figure 8: Data entry form



4.0 DISCUSSION AND CONCLUSION

The SATWQM project is directed towards securing a sustainable environment in South Asia to protect the region from the effects of environmental degradation. The project also increases regional cooperation and confidence building in South Asia, thereby lessening tensions in a volatile area.

Among the most basic needs of people in developing countries are the development and management of safe drinking water and adequate quantities of irrigation water optimally used for sustainable food production. The application of new technologies will be crucial to providing adequate and safe water supplies in the developing countries that make up South Asia. Effective applications of new technologies will occur only through free and open access to information, the sharing of relevant data on a regional watershed basis, and the involvement of leading science and technology research institutions in the region and globally.

In the US, hydrological information for the assessment of US water resources availability and quality, as well as prediction of natural or man-made stress is freely available to the public. This entails coordination between the Federal, State, Tribal and local governments and the private sector. This is a model that could be emulated in South Asia. The sharing of water-related data and information is critical to fulfilling the unmet needs of providing access to safe water to the people of South Asia.

In preparing for the World Summit on Sustainable Development held in South Africa in August 2002, regional roundtables have been held around the world. Central and South Asian countries have prepared a regional roundtable report that contains several proposals for action. One of these proposed actions recommends increased "Access to Information, Public Participation and Access to Justice in Environmental Matters" through the use of information technology for "segments of the population that can greatly benefit from greater access to information". The roundtable report also states, "The innovative capacity of this region's scientists, engineers and business community should be pooled and advanced so that the potential in the area of information technology can be fully utilized."

Fulfilling the mission of providing equitable access to environmental information in South Asia can benefit greatly from US assistance and by learning from and building upon the US experience. The US is the world's leader in providing public access to environmental information using the Internet – especially in the area of water resources and water quality data. For example, the US Geological Survey (USGS) provides on-line access to real-time water flow and water quality sensors (for both surface water and groundwater), as well as on-line access to previously published reports for every zip code and watershed in the US. The U.S. Environmental Protection Agency (EPA) has an Internet-based system called "Surf Your Watershed" that links to the USGS data, as well as other environmental information provided by the EPA and related agencies. Emulating and learning from these programs of US entities could result in markedly improved water quality data and information sharing in South Asia.

The SATWQM project database being created is unique in its transboundary and regional focus, and is, therefore, likely to become an important part of other current or future South Asian water resources studies. Although presently limited in scope to a few key indicator parameters, the information from the SATWQM project can potentially complement the use of computer models that predict flow and transport. Information between sampled locations can then be inferred from such models with greater validity. In addition, the use of decision support systems can assist in the sustainable management of resources and the environment.

The monitoring studies that have been initiated in this project are a small step towards the large-scale regional and well-coordinated monitoring programs that are needed to fully understand the complex watersheds of South Asia. In the future, in each of the study areas, a larger set of hydrologic parameters will need to be monitored on a frequent basis. The specific monitoring that will be needed within each of the selected areas will be determined on the basis of the physical layout of the basin, the objectives of the study within that area, and on the availability of instrumentation within the basin. With the establishment of large-scale monitoring efforts, the periodic observations made will be able to detect the impact of human activities and natural processes simultaneously in different locations across national boundaries.

The main purpose of the SATWQM project network is to demonstrate technology and data sharing capabilities. Therefore, the focus of the project is on promoting a regional water-related data sharing process, and not simply on the data itself. After development of the project infrastructure, the transfer of appropriate technologies, and the training of regional participants, it is hoped that the network will be expanded in subsequent projects by regional entities. By demonstrating the ease and utility of cross-border sharing of data, the modest effort described here hopes to expand into a much larger scale and government-led effort.

REFERENCES

Rajen, G., Betsill, J.D., Biringer, K., 2001, *The South Asia Cooperative Environmental Monitoring Project: An Effort to Promote Regional Cooperation and Water Quality Data Sharing in South Asia,* Cooperative Monitoring Center, Sandia National Laboratories, USA, SAND2001-0722.

APPENDIX A

LIST OF PARTICIPANTS IN PHOTOGRAPH DEPICTED IN FIGURE 1.

Rows are numbered 1-6, starting with the back row as number 1 and the front row as number 6.

Row 1 (L to R)

- Ambassador Michael Malinowski, U.S. Embassy, Kathmandu, Nepal (US Govt.)
- Mr. Jyotirmoy Mukherjee, Research Associate, CED, Kolkata, India (NGO)
- Dr. Ravindra K. Sinha, Professor, Department of Biology, Patna University, Patna, India (Academic)
- Mr. Michael DeTar, Regional Environmental Affairs Officer, US Embassy, Kathmandu, Nepal (US Govt.)
- Mr. Frederick O. Luetters, Manager, International Security Initiatives Department, CMC, Albuquerque, USA (US Govt.)

Row 2 (L to R)

- Mr. Hammad Naqi Khan, Director, Environment Pollution Unit, World Wide Fund for Nature-Pakistan, Lahore, Pakistan (NGO)
- Dr. Dipak Gyawali, Managing Director, NWCF, Kathmandu, Nepal (NGO)
- Mr. Adam F. Friedensohn, Chairman, Lotus Energy Pvt. Ltd., Kathmandu, Nepal (Industry)
- Dr. Gaurav Rajen, Consultant, CMC, Albuquerque, USA (US Govt.)
- Dr. Kriteswar Prasad, Professor, Department of Geology, Patna University, Patna, India (Academic)

Row 3 (L to R)

- Dr. Anish Dua, Lecturer, Department of Zoology, Guru Nanak Dev University, Amritsar, India (Academic)
- Dr. Bed Mani Dahal, Kathmandu University, Kathmandu, Nepal (Academic)
- Dr. Masil Khan, Project Officer, Environment Pollution Unit, World Wide Fund for Nature-Pakistan, Lahore, Pakistan (NGO)
- Mr. Anthony Carvalho, US AID, Kathmandu, Nepal (US Govt.)
- Dr. Narayan P. Upadhaya, Director, Environment Monitoring Division, ENPHO, Kathmandu, Nepal (NGO)
- Col. (Ret.) V. Katju, Manager, Environmental Action Program, Development Alternatives, Delhi, India (NGO)

Row 4 (L to R)

- Mr. Jay Pal Shrestha, Regional Environmental Affairs Specialist, US Embassy, Kathmandu, Nepal (US Govt.)
- Dr. Brij Sahni, Program Manager, Natural Resources Management, Winrock International, Delhi, India (NGO)
- Dr. A.K. Ghosh, Director, CED, Kolkata, India (NGO)
- Mr. Kanchan Dixit, Ecologist, NWCF, Kathmandu, Nepal (NGO)
- Dr. Asad S. Qureshi, Regional Director, IWMI, Lahore, Pakistan (NGO)

- Dr. J. David Betsill, Environmental Projects Manager, Senior Technical Staff Member, CMC, Albuquerque, USA (US Govt.)

Row 5 (L to R)

- Dr. Roshan Raj Shrestha, Executive Director, ENPHO, Kathmandu, Nepal (NGO)
- Mr. Shyam Sundar Ranjitkar, Irrigation Specialist, World Bank, Kathmandu, Nepal (International financial institution)
- Mr. Khalilur Rahman, Executive Director, Bangladesh Unnayan Parishad, Dhaka, Bangladesh (NGO)

Row 6 (L to R)

- Mr. Roy K. Boerschke, Program Coordinator, World Bank Office, Dhaka, Bangladesh, (International financial institution)
- Dr. K.B.S. Rasheed, Bangladesh Unnayan Parishad, Dhaka, Bangladesh (NGO)
- Dr. Keshari Bajracharya, Senior Divisional Chemist, Nepal Ministry of Hydrology and Meteorology, Kathmandu, Nepal (Govt.)
- Ms. Mandira Shrestha, Mountain Natural Resources Division, International Center for Integrated Mountain Development, Kathmandu, Nepal (NGO)
- Dr. Usha Sharma, Program Officer, World Conservation Union, Kathmandu, Nepal (NGO)
- Dr. Bandana Kayastha Pradhan, National Consultant, International Center for Integrated Mountain Development, Kathmandu, Nepal (NGO)
- Robin Lall Chitrakar, Department of Water Supply and Sewerage, Kathmandu, Nepal (Govt.)
- Bikash Pandey, Country Representative, Winrock International, Kathmandu, Nepal (NGO)

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