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South Asia Water Resources Workshop: An Effort to Promote Water Quality Data Sharing in South Asia

Gaurav Rajen, Kent L. Biringer, and J. David Betsill

Prepared by
Sandia National Laboratories
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South Asia Water Resources Workshop: An Effort to Promote Water Quality Data Sharing in South Asia

Prepared for
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Abstract

To promote cooperation in South Asia on environmental research, an international working group comprised of participants from Bangladesh, India, Nepal, Pakistan, Sri Lanka, and the United States convened at the Soaltee Hotel in Kathmandu, Nepal, September 12 to 14, 1999. The workshop was sponsored in part by the Cooperative Monitoring Center (CMC) at Sandia National Laboratories in Albuquerque, New Mexico, USA, through funding provided by the Department of Energy (DOE) Office of Nonproliferation and National Security. The CMC promotes collaborations among scientists and researchers in regions throughout the world as a means of achieving common regional security objectives.

In the long term, the workshop organizers and participants are interested in the significance of regional information sharing as a means to build confidence and reduce conflict. The intermediate interests of the group focus on activities that might eventually foster regional management of some aspects of water resources utilization. The immediate purpose of the workshop was to begin the implementation phase of a project to collect and share water quality information at a number of river and coastal estuary locations throughout the region.

The workshop participants achieved four objectives: 1) gaining a better understanding of the partner organizations involved; 2) garnering the support of existing regional organizations promoting environmental cooperation in South Asia; 3) identifying sites within the region at which data is to be collected; and, 4) instituting a data and information collection and sharing process.

Acknowledgments

The workshop organizers gratefully acknowledge support from the U.S. Department of Energy (DOE) Office of Nonproliferation and National Security. We also thank Deborah Seligsohn and Bobby Chettri of the American Embassy in Kathmandu, Nepal for support in arranging the workshop. Special thanks go to Patricia Dickens for her help with logistical arrangements.

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Acronyms

ACDA	U.S. Arms Control and Disarmament Agency
AID	U.S. Agency for International Development
BUP	Bangladesh Unnayan Parishad
CMC	Cooperative Monitoring Center
COMAPS	Coastal Ocean Monitoring and Prediction System
CSBM	confidence and security building measure
DOE	U.S. Department of Energy
DOS	U.S. Department of State
ftp	file transfer protocol
ICIMOD	International Center for Integrated Mountain Development
IUCN	World Conservation Union
NGO	nongovernmental organization
NIO	National Institute of Oceanography
NWCF	Nepal Water Conservation Foundation
NWS&DB	National Water Supplies and Drainage Board
PEEMAC	Pakistan Energy and Environmental Management Center
PNECC	Pakistan National Energy Econservation Center
PSG	Peace Studies Group, University of Calcutta
SAARC	South Asian Association of rRegional Coorpeation
SACEP	South Asia Cooperative Environment Program
SARS	South Asia Research Society
TBIA	Thane-Belapur Industries Association
U.S.	United States

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1. Introduction and Background

To promote cooperation in South Asia on environmental research, an international working group comprised of participants from Bangladesh, India, Nepal, Pakistan, Sri Lanka, and the United States convened at the Soaltee Hotel in Kathmandu, Nepal, September 12 to 15, 1999. (Figure 1 depicts the workshop participants. See Appendix A for a list of names.) The aim of the workshop was to initiate a process of sharing water-related data among the participating researchers. This report summarizes the workshop objectives, process, and results.

Figure 1. Workshop Participants

In the context of the nuclear tests by India and Pakistan and the declared intentions by both countries to deploy nuclear weapons as deterrents, there is an urgent need to promote confidence and security building measures (CSBMs) in South Asia. In this context, the lessening of tensions through CSBMs such as cooperative environmental projects can reduce the risk of conflict and enhance collective security objectives in South Asia (Singh, 1996; Ganguly and Greenwood, 1996; Biringer, 1998). The driving motivation behind the workshop was to develop such CSBMs.

The workshop was sponsored in part by the Cooperative Monitoring Center (CMC) located at Sandia National Laboratories in Albuquerque, New Mexico, USA, through funding provided by the U.S. Department of Energy (DOE) Office of Nonproliferation and National Security. It was co-hosted by the American Embassy in Kathmandu. The CMC promotes collaborations among scientists and researchers in regions throughout the world as a means of achieving common

regional security objectives. The CMC and Sandia National Laboratories have significant technical expertise that can be applied to cooperative monitoring projects, including environmental projects. Examples include high-resolution remote sensing, data transmission and security, computer modeling, data management and decision support tools, and an infrastructure to support cooperative monitoring efforts. In addition, the CMC collaborates with the U.S. Geological Survey, the U.S. Environmental Protection Agency, the U.S. Bureau of Reclamation, numerous universities, and local and state governments. To accomplish the workshop's objectives, the CMC is partnering with a diverse group of organizations from South Asia and the U.S., representing government, business, academic, and research institutions.

The principal workshop theme is that cooperation to ensure a sustainable environment can improve relations between countries. Environmental cooperation can provide general nonmilitary CSBMs when the level of hostility and mistrust between parties precludes the possibility of CSBMs in more sensitive militarily related areas (Ahmed and Das, 1998). The Red Sea Marine Peace Park in Jordan (created as a part of the Israeli-Jordanian peace-seeking process) provides an excellent example of such environmental cooperation. Even if one contests the premise that environmental cooperation can lead to a solution of security-related problems, the lack of environmental cooperation has the potential to exacerbate strained relations between countries. Gleditsch (1998) reviews numerous studies that establish a link between environmental scarcity and violent conflict. A recent report by the World Commission on Water has concluded that there are now more environmental refugees (displaced by the lack of natural resources such as fertile soil and adequate water supplies) than war refugees. (World Commission on Water, 1999) Many disputes over territorial borders involve the contested ownership of resources or access to the resources. Degradation and the depletion of agricultural land, forest, water, and fish stocks are examples of environmental factors that can increase the potential for armed conflict. Along with the benefits of improved sustainability, environmental cooperation among countries also has several indirect security-related benefits. Environmental cooperation increases dialogue between policymakers 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 (Pregenzer, Vannoni, and Biringer, 1996.)

The project on promoting regional water-related data sharing in South Asia had its genesis in March 1998 when the CMC held an environmental monitoring workshop hosted by the Peace Studies Center of the University of Calcutta and the South Asia Research Society (SARS) in Calcutta, India. This workshop was co-sponsored by the U.S. Arms Control and Disarmament Agency (ACDA) and DOE. Subsequently, in June 1998, 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 Ganga-Brahmaputra-Meghna River Basin and sustainability of the Sundarbans mangrove forest area.

In South Asia's Ganga River Basin, effective water management requires rapid access to accurate, reliable, and spatially and temporally continuous data. The development of predictive models that can integrate and analyze water resources data necessitates a holistic approach that transcends the political boundaries dividing this basin. In the Ganga River Basin, unfortunately, effective water resource management is constrained by the lack of data sharing among

neighboring countries. Comprehensive predictive models remain difficult to develop. The security of millions of people is endangered through increasing water scarcity, floods, excessive sedimentation, drastic changes in river morphology, reduced dam safety, salinization of fresh waters, loss of arable lands, and environmental degradation of unique habitats such as the mangrove forests of the Sundarbans (in the Ganga delta).

One of the main conclusions of the June 1998 workshop held at the CMC was that a pressing need existed within South Asia to foster greater openness and sharing of water resources information. It was further recognized that water quality data might be easier to gather and share among regional partners than water quantity data that would be considered more sensitive by concerned government agencies. As a result of these findings, a project was initiated by the CMC to develop a partnership with a network of entities within various South Asian countries to begin sharing nonsensitive environmental and water quality data. Currently, the project is focusing on water quality issues common to Bangladesh, India, Nepal, Pakistan, and Sri Lanka. The data to be collected include water quality information from select locations on the Ganga and Indus rivers and some coastal regions. Figure 2 depicts the areas relevant to the project.

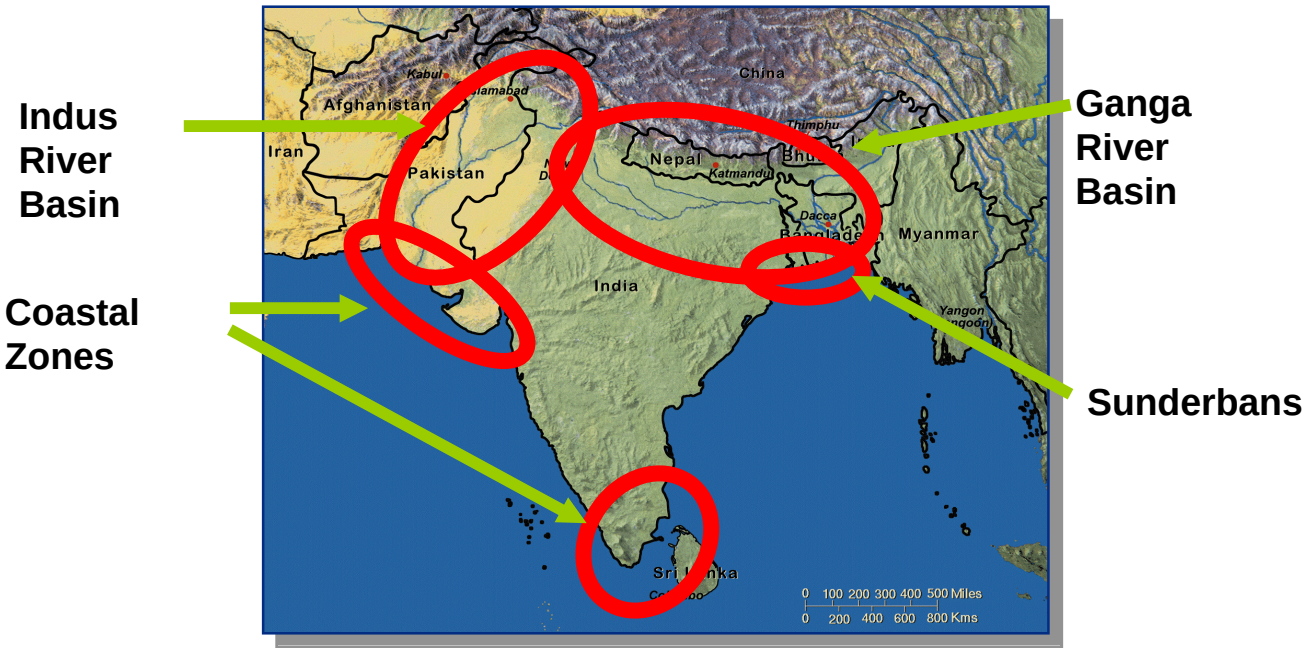

Figure 2. Relevant Areas

The regional project partners are to perform the following tasks:

- Select sampling locations (along rivers or in estuarine/delta regions) and provide detailed information on the sites chosen (access details, maps, and photographs);
- Collect data at chosen locations using hand-held water quality measurement instruments and share data gathered among the parties via the CMC over the Internet.

2. Workshop Objectives and Process

For the long term, the workshop organizers and participants are interested in the significance of regional information sharing as a means to build confidence and reduce conflict. In an area of high tensions such as South Asia, information-sharing efforts set the stage for expanded future cooperation in resolving contentious disputes such as overlapping territorial claims. The intermediate interests of the group are focused on activities that might eventually foster regional management of some aspects of water resources utilization. The immediate purpose of the workshop and the ongoing project is to implement the collection and sharing of water quality information at a number of river and coastal estuary locations throughout the region.

The workshop brought together regional partners as well as U.S. government personnel from the American Embassy, the U.S. Agency for International Development (AID), 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, as well as several regional government and nongovernment organizations that may be involved in an informal or more active role in the future.

The individuals participating actively in the project are listed in Table 1 (in alphabetical order by country). Under a combination of contractual and voluntary arrangements each partner will collect water quality data using instrumentation provided by the CMC. Other participating organizations have agreed to share existing data with the project. All data are to be posted to a central Internet web site for collaborative use in the region.

Other participants in the workshop were (in alphabetical order):

- Abdul A. Azeez, Director, South Asia Association for Regional Cooperation Secretariat, Kathmandu, Nepal (intergovernmental)
- Keshari Bajracharya, Nepal Ministry of Hydrology and Meteorology, Kathmandu, Nepal (government)
- Anthony Carvalho, U.S. AID, Kathmandu, Nepal (government)
- Suresh Raj Chalise, Director of Mountain Development Programs, International Center for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal (nongovernmental organization [NGO])
- Drona Ghimire, Program Manager, World Conservation Union (IUCN), Kathmandu, Nepal (NGO)
- Ananda R. Joshi, Director-General, South Asia Cooperative Environment Programme (SACEP), Colombo, Sri Lanka (intergovernmental)
- William Robert Laitos, U.S. AID, Kathmandu, Nepal (government)
- Shyam Sundar Ranjitkar, Irrigation Specialist, World Bank, Kathmandu, Nepal (international financial institution)
- Deborah Seligsohn, First Secretary of Environmental Affairs, U.S. Embassy, Kathmandu, Nepal (government)

Table 1. List of Active Partners

Country	Organization	Point of Contact
Bangladesh	Bangladesh Unnayan Parishad (BUP), Dhaka, Bangladesh (NGO)	Ahsan Uddin Ahmad, Director of Environment Programs
India	Thane-Belapur Industries Association (TBIA), Mumbai (Industry) South Asia Research Society (SARS), Calcutta (NGO)	Dinesh Parekh, President J.K. Ray, Director
Nepal	Nepal Water Conservation Foundation (NWCF), Kathmandu (NGO)	Dipak Gyawali, Managing Director
Pakistan	Pakistan Energy and Environmental Management Center (PEEMAC), Islamabad (Government)	Arif Alauddin, Managing Director
Sri Lanka	National Water Supplies and Drainage Board (NWS&DB), Colombo, Sri Lanka (government)	Nimal Padmasiri, Director of Laboratories
USA	Cooperative Monitoring Center (CMC), Albuquerque (government and industry)	Kent Biringer, Distinguished Member Technical Staff; J. David Betsill, Senior Member Technical Staff; Gaurav Rajen, Visiting Scholar

The more informal participants can be further subdivided into two groups. One group is likely to become increasingly involved in the project as it develops. The other group will observe and offer limited assistance through coordination and advice. The membership in these two types of groups will evolve as the project matures. Transitions will occur between the two groups and new members are likely to join these informal groupings.

2.1 Workshop Structure

The workshop focused on achieving four key objectives: 1) gaining a better understanding of the partner organizations involved; 2) garnering the support of existing regional organizations promoting environmental cooperation in South Asia; 3) identifying sites within the region at which data are to be collected; and 4) instituting a data and information collection and sharing process. The sessions included

- project and program summaries
- technology
- data processing and communication
- next steps

Appendix B contains a detailed agenda. A portion of the workshop focused on developing a web site that will provide information on South Asian cooperative environmental monitoring projects and their conceptual development. The workshop also included a demonstration of the selected water quality measuring instrument and an impromptu field trip to the Bagmati River for a joint collection of water quality data to inaugurate the project.

2.2 Workshop Process

The first day of the workshop focused on background presentations on ongoing environmental monitoring projects in the region and other parts of the world. The workshop and project concept has been strongly endorsed by the U.S. State Department. U.S. Ambassador to Nepal Ralph Frank provided the opening workshop address (Figure 3). Kent Biringer, South Asia Projects Manager at the CMC, presented an overview of cooperative monitoring concepts and the specific water quality project objectives and plan. David Betsill, Environmental Projects Manager at the CMC, described a recent collaborative environmental project conducted with CMC assistance between Israel and the Palestinian Authority to further sustainable land use objectives in the desert regions of the Middle East. Next, each of the workshop observer organizations described their programs on environmental monitoring. These presentations were followed by regional partners' presentations on specific project water monitoring plans. The plans included descriptions of candidate monitoring sites. The sites selected are:

- Bangladesh: Various sites on the Ganga, Brahmaputra, and Meghna Rivers
- India: Thane Creek, Mumbai; Hoogli River, Calcutta
- Nepal: Bagmati River, Kathmandu
- Pakistan: Rawal Dam, Islamabad
- Sri Lanka: Kelani River, Colombo

Figure 3. Ambassador Ralph Frank Addresses Workshop Participants

On the second day, David Betsill discussed the significance of the selected water quality parameters. Table 2 lists the parameters to be measured. First, the project involves manual data collection and transmittal. In the next phase, the project participants will set up systems for gathering data remotely and sending data to an Internet web site electronically. Site selection criteria included: relevance to the goals of the project; relevance to the individual partners and their goals; collection of data that are nonsensitive and freely sharable; and accessible locations for partners collecting data.

Table 2. Parameters to be Measured

Parameter to be Measured
pH
Conductivity
Specific Conductivity
Salinity
Temperature

Gaurav Rajen, a Visiting Scholar at the CMC, demonstrated the water quality instrumentation that is being provided to each project partner (Figure 4). The instrument selected for the project is a commercial pH, temperature, conductivity, and salinity meter with a digital readout. Gaurav Rajen also demonstrated a prototype Internet site developed for the project. This site will serve as a home for data gathered and a link to regional web sites on the environment. The web site is described further in Section 3.4. Data format and transmission issues were addressed. Several of the observer organizations offered to supply existing data to further enhance the project. These included ICIMOD, IUCN, the Nepal Department of Hydrology and Meteorology, and SACEP.

Figure 4. Workshop Participants Observing an Instrument Demonstration

Kent Biringer presented other opportunities for regional environmental cooperation. Gaurav Rajen presented his analysis of potential coastal zone cooperation for India and Pakistan (Rajen, 1999). The workshop concluded with a discussion of the next steps in implementing the project. A ceremonial collection of the first project data in the Bagmati River in Kathmandu was the workshop finale. Table 3 lists the water quality values measured; Figure 5 shows participants collecting water data.

Table 3. Water Quality Values Measured at the Bagmati River by Workshop Participants

Parameter Measured	Value
pH	7.25
Conductivity	207.8 microSiemens
Specific Conductivity	201.3 microSiemens
Salinity	0.1 parts per thousand
Temperature	26.7 ^{o} Celsius

Figure 5. Collecting Data at the Bagmati River

3. Workshop Results

This section summarizes the major outcomes of the workshop. Descriptions of the organizations involved are primarily from informational materials provided by the participants at the workshop.

3.1 Understanding the Organizations Involved and Regional Support

Three kinds of organizations were represented at the workshop. Active partners (listed in Table 1 and described in Appendix C) will collect and share water quality data in collaboration with the CMC. The second set represents regional or country-specific organizations that are committed to progressively becoming more involved in the project. This second set is already involved in the gathering and sharing of environmental information, including water quality data. This set includes SACEP, ICIMOD, and the U.S. Department of State's (DOS's) Regional Environmental Affairs Office. (See Appendix C.) The third set includes organizations that were present at the workshop purely to observe and offer advice and assistance in future coordination efforts with other ongoing regional activities. These include the IUCN, South Asian Association for Regional Cooperation (SAARC), the World Bank, the Nepal Department of Hydrology and Meteorology and U.S. AID.[1]

3.2 Identifying Sites

At the workshop, the active partners suggested a mix of rivers, coastal locations, and lakes as project sites. After the workshop, the active partners selected the bodies of water and specific sampling locations.[2]

3.2.1 Bangladesh

The Bangladesh Unnayan Parishad (BUP) selected 26 distinct locations on major and minor streams in the Ganga-Brahmaputra-Meghna Delta for sampling, listed in Table 4.

3.2.2 India

The SARS selected two sampling sites, Palta and Uluberia, on the Hoogli branch of the Ganga River near Calcutta. The Palta station is upstream from Calcutta near Barrackpore, in the North 24 Parganas district of the Indian State of West Bengal. The Uluberia station is in the Howrah district, downstream from Calcutta. Figure 6 shows a view of the Hoogli River at the Palta station and Figure 7 depicts a sampling team of the SARS.

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1 Given their informal level of participation and the considerable volume of publicly available information that exists for most of these organizations, these organizations are not described here in any detail.

2 The project web site provides a detailed map identifying these locations by their geographical coordinates.

Table 4. Rivers and Locations Selected by the BUP

River	Location
Baleswari	Kowkhali
Baleswari/Ghashiakhali Confluence	Baramusa
Brahmaputra	Mymensingh
Buriganga	Dhaka (Sadar Ghat)
Dhaleswari	Pagla (Dhaka)
Dhaleswari/Sitalakhya Confluence	Munshiganj
Gabkhan	Hularhat
Gabkhan/Salidaha Confluence	Charkhali
Ganga (Padma)	Mawa
	Pakshi
	Rajshahi
Ganga/Jamuna Confluence	Aricha/Daulatdia
Ghashiakhali	Morrelgonj
Jamuna	Bhuapur
Karnaphuli	Chittagong (Jetty)
	Chittagong (Patenga- sea front)
Karotoa	Bogra
Kirtankhola	Barisal
Kirtankhola/Bishkhali Confluence	Jhalokathi
Meghna	Norshingdi
Meghna (Lower)	Chandpur
Pasur	Mongla
Rupsha/Bhairab Confluence	Khulna
Sitalakhya	Narayanganj
Surma	Sylhet
Turag	Tongi

The Thane-Belapur Industries Association (TBIA) selected the Chembur-Thana Bridge on the Thane Creek as their sampling location. Figure 8 depicts a view from this bridge. One of the world's highest concentrations of chemical industries is along the Indian mainland adjacent to the island of Mumbai in an area called Thane-Belapur. The region is densely populated, with approximately 8,000,000 inhabitants in the city of Mumbai and over 14,000,000 in the Mumbai metropolitan region.

Figure 6. A View Near the Palta Station on the Hoogli River

Figure 7. SARS Sampling Team Conducting Fieldwork at the Palta Station

There is concern that pollutants discharged into Thane Creek, which divides the island of Mumbai from the Thane-Belapur region, are trapped by the tidal flows that move in and out of the creek system. Tidal flows in this area, however, are not well understood, and the pollution load is not well characterized. The Indian government is proceeding with massive plans to develop a new city called Navi Mumbai (or New Mumbai) on the Indian mainland, to ease pressures from the overcrowded city of Mumbai. Since 1991, India's Department of Ocean Development, headquartered in New Delhi, has measured marine environmental parameters under its Coastal Ocean Monitoring and Prediction System (COMAPS).

Figure 8. A View from the Chembur-Thana Bridge on Thane Creek (Looking Northeast)

The National Institute of Oceanography (NIO), with headquarters in Panjim, Goa, administered the COMAPS program through its regional center in Mumbai. In the vicinity of Mumbai, the COMAPS program has identified several areas of potential and known concern. In the areas of known concern, "the levels of dissolved oxygen reached 'nil' values during low tides and showed abnormal values of human pathogens." (*1997-98 Annual Report of the Indian Department of Ocean Development*) These levels are presumed to occur mainly because of the disposal of untreated sewage and industrial effluents.

3.2.3 Nepal

The Nepal Water Conservation Foundation (NWCF) selected a stretch of the Bagmati River within the city of Kathmandu for sampling.

The Bagmati River is the main perennial water body of Katmandu valley, originating from Baghdwar, which is situated at an altitude of 2650 m north of the valley at Mahabharat hills. The river flows along the slope of Kathmandu Valley of 662 km^2, and comes down to the plains of Nepal and enters into India to merge with the Ganga. It runs more than 30 km within the valley. The main source of water for the Bagmati is rainfall and spring flow. The flow is at a minimum in the months of April and May and peaks in the monsoon, usually in July or August. The river serves as a major source of water resources in Kathmandu Valley. The river water is used for drinking, irrigation, domestic, religious, cultural, and hydroelectricity production purposes.

Approximately 0.74 million people inhabited Kathmandu Valley according to the census of 1991. It has three important cities: Kathmandu, Patan, and Bhaktapur. The valley is partly urban and partly rural. The average population growth is estimated at 3.5% per annum for urban areas of Greater Kathmandu. The urban and population growth in Kathmandu Valley has led to problems of pollution in the Bagmati. Figure 9 illustrates some of the urban runoff that drains into the Bagmati River.

Figure 9. Urban Runoff Draining into the Bagmati River in Kathmandu

Within the past decade, the Bagmati, considered sacred by most Nepalis, has turned into a major sewage outlet of the city of Kathmandu. Pollution in the river stems from rapid urbanization; the inadequacy of solid waste, wastewater, and industrial effluents disposal; agricultural runoff; and malfunctioning of the sewer system. Previous studies (to which NWCF staff provided guidance) demonstrated that water quality stays degraded for at least 7 km past the city of Kathmandu. High concentrations of fecal and total coliform bacteria and low oxygen levels were characteristic of the river water quality in most sections within Kathmandu.

To assess trends in the water quality of the Bagmati, the NWCF is coordinating its planned sampling program with the Nepal Department of Hydrology and Meteorology. Approximately six locations are being studied as candidate sites for further sampling.

3.2.4 Pakistan

The Pakistan Energy and Environmental Management Center (PEEMAC) has selected the reservoir at Rawal Dam near Islamabad and Rawalpindi as the site at which data will be gathered. The PEEMAC plans to develop an independent web site and post the data they gather directly on the web. The CMC web site will then make a link to this web site.

Rawal Dam forms a lake that is the sole drinking water reservoir for the city of Rawalpindi. Untreated urban wastewater effluents, runoff from poultry farms, and pollutants released during the recreational use of motorboats are among the sources suspected of contaminating the lake. The climatic temperature at Rawal Dam/Lake varies from an average maximum in winter of

17°C to an average minimum of 3°C. In summer, the temperature varies from 34°C to 24°C. Rawal Dam is situated at the foot of the Murree Hills, in an area that forms the northeast part of the Potwar Plateau. The lake is an important resource as a sports and commercial fishery. Fish yields in the lake have declined in recent years. Figure 10 depicts PEEMAC-sponsored water quality sampling at Rawal Lake.

Figure 10. Water Quality Sampling at Rawal Lake

3.2.5 Sri Lanka

The National Water Supplies and Drainage Board (NWS&DB) selected the Kelani River estuary for further study. This river originates in highlands in two main tributaries (Kehelgamuoya and Maskelioya) that flow along valleys to join and form the Kelani. The Kelani River eventually flows out into the Indian Ocean from the west coast of Sri Lanka near the city of Colombo. Figure 11 depicts a view of the Kelani River upstream from the coast near Colombo. From an economic perspective, the Kelani forms the most significant watershed in Sri Lanka for the following reasons:

- It flows through the economically important Western Province in which the capital city Colombo is located.
- Major industrial establishments and rapidly industrializing areas are located along its banks (textiles, footwear, leather goods, rubber products, processed foods, metal products, and electronics assembly).
- Timber is transported from the highlands along the Kelani.
- The banks are densely populated and the residents utilize the river water for all their daily requirements.
- Intake of water for the supply of water to the city of Colombo is located about 13 km from the river mouth.
- Sand mining along the river has created a problem of saltwater intrusion.

Figure 11. A View of the Kelani River Upstream from the Coast near Colombo

3.3 Data and Information Collection and Sharing

As more specific site details become available, sampling and quality assurance plans will be prepared. Each partner will follow environmental sampling guidelines and Standard Operating Procedures developed by the appropriate environmental regulatory authority in the country of data collection. Sharing this information will itself create greater transparency. The partners plan to maintain thorough field notes in bound and numbered record books. A field data collection form developed by the U.S. Environmental Protection Agency has been selected as a guide. A copy of this form filled out by the SARS is provided in Appendix D. Communication of the data collected will be via the Internet (e-mail or file transfer protocol [ftp]).

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

- precision
- accuracy
- representativeness
- comparability
- completeness

Each partner is expected to assess and document the level of data quality. Sampling situations vary widely. 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 freely accessible to the project staff and managers.

The following types of information will be sent:

- Static and quasi-static information sent infrequently. This information will describe sampling sites in detail. This information can be faxed, mailed, or sent as electronic attachments.
- Periodic information on a site that is already described will be sent (at a minimum) weekly via e-mail or ftp, as follows:
  - site identification (ID) number
  - date and time
  - brief field notes
  - data in the units as reported in the meter

A web-based form is under development that will allow each partner to enter data as needed from the project web site.

3.4 Web Site

The project web site (http://cooper.cmc.sandia.gov/dahaycr/sasia/southasia.html) is designed to

- provide links to existing data sources,
- present partner information, and
- share water quality data generated by partners.

As shown in Figure 12, the 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:

- More information about the project
- More information about the partners
- Links to international, regional and country-specific data sources

The Data Sources button links to numerous sources that are relevant to or from the South Asian region. The participants hope to make this a data and information system that will be continually expanded and of value to South Asian researchers. They also plan to transition operation and maintenance of the site to regional entities.

Other buttons provide language support, a utility to search the site, and acknowledgements. There is also a graphical display with a map of South Asia that provides access to the data being collected through the project.

Figure 12. Web Site Home Page

Figures 13 through 17 show the sequence of frames that allow a viewer to access the water quality data being gathered. This sequence uses data gathered in Albuquerque by the CMC as an example. A similar sequence of frames leads the viewer to data for each South Asian country. The viewer starts the sequence by clicking on the circles representing sample collection sites in a country of choice. As shown in Figure 13, clicking on the graphical display brings up a map with active points that can be clicked again to access more information. Figure 14 shows how clicking on the CMC project site (shown as a button on the map of the U.S.) brings up a regional map with buttons representing regional data collection points. Figures 15 through 17 depict how clicking on the regional site buttons brings up even more detailed maps with buttons that can be clicked again to access local site data. Eventually, by selecting a specific local sampling site, the viewer sees photographs and can access graphical and numerical displays of data.

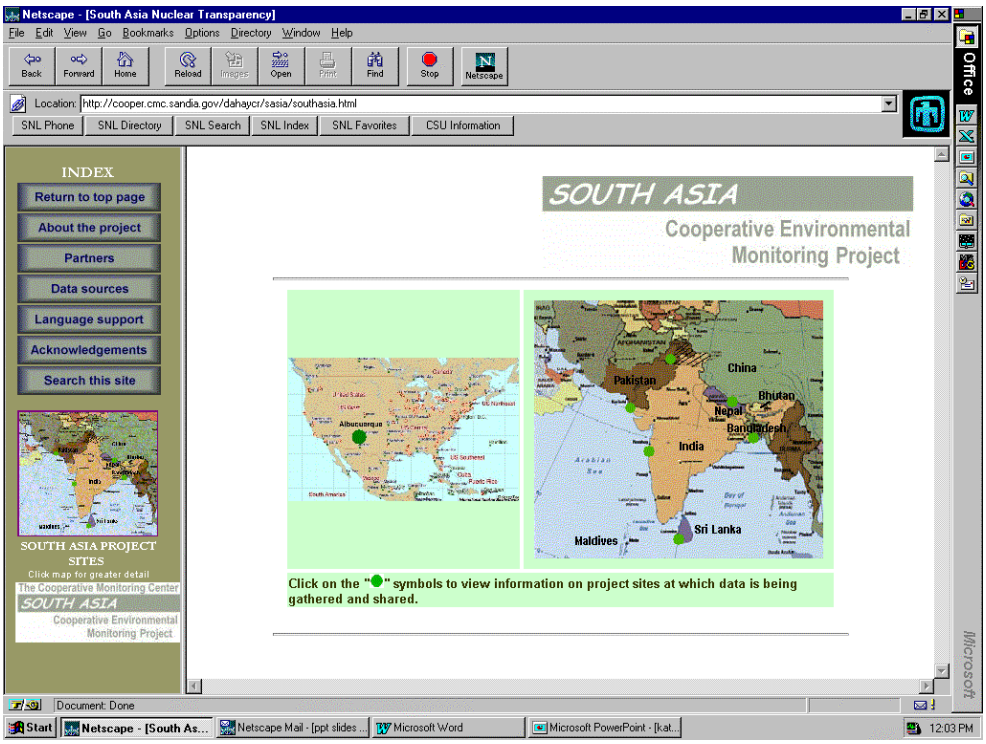

Figure 13. Graphical Display with Active Points that Can Be Clicked to Access More Information

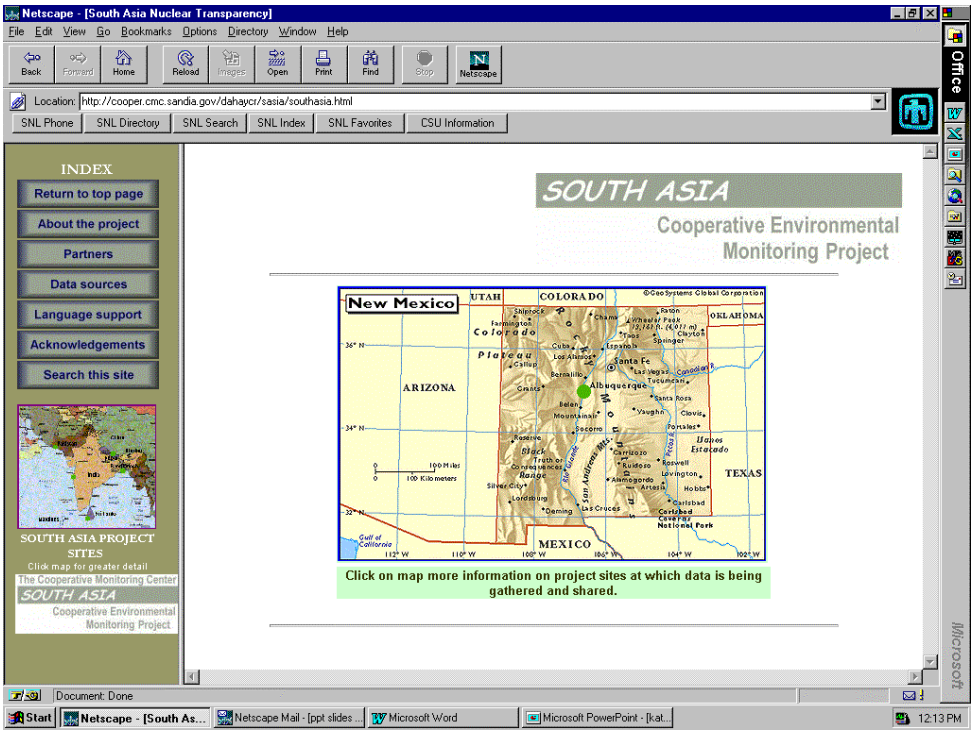

Figure 14. CMC Project Site Regional Map with Buttons Representing Regional Data Collection Points

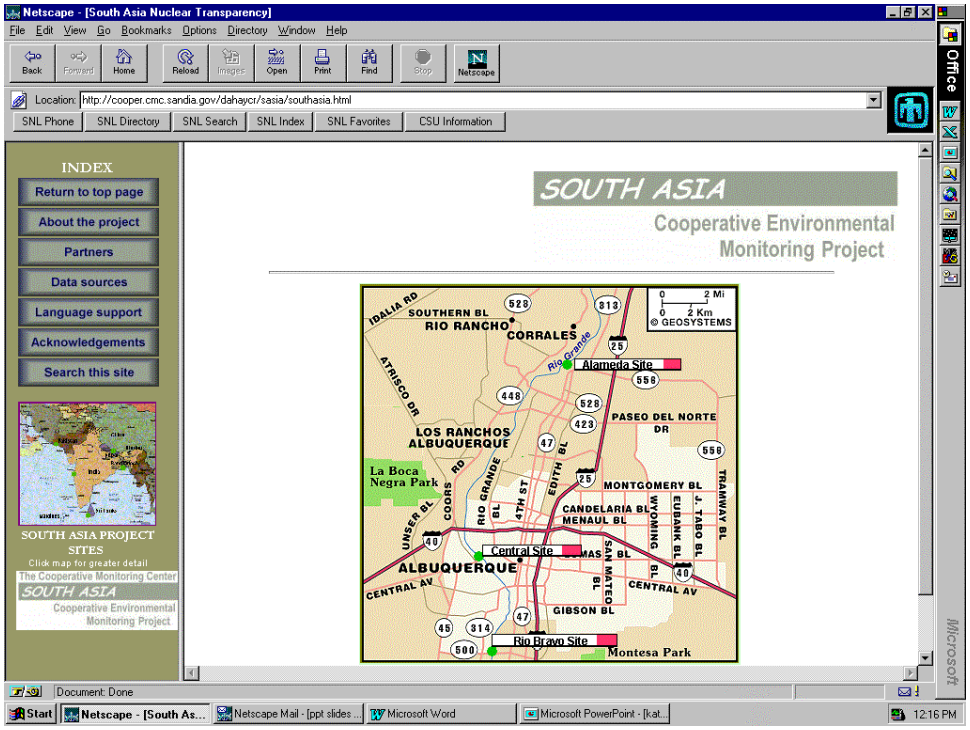

Figure 15. Detailed Map of the CMC Project Sampling Area with Buttons that Can Be Clicked Again to Access Local Sampling Station Data

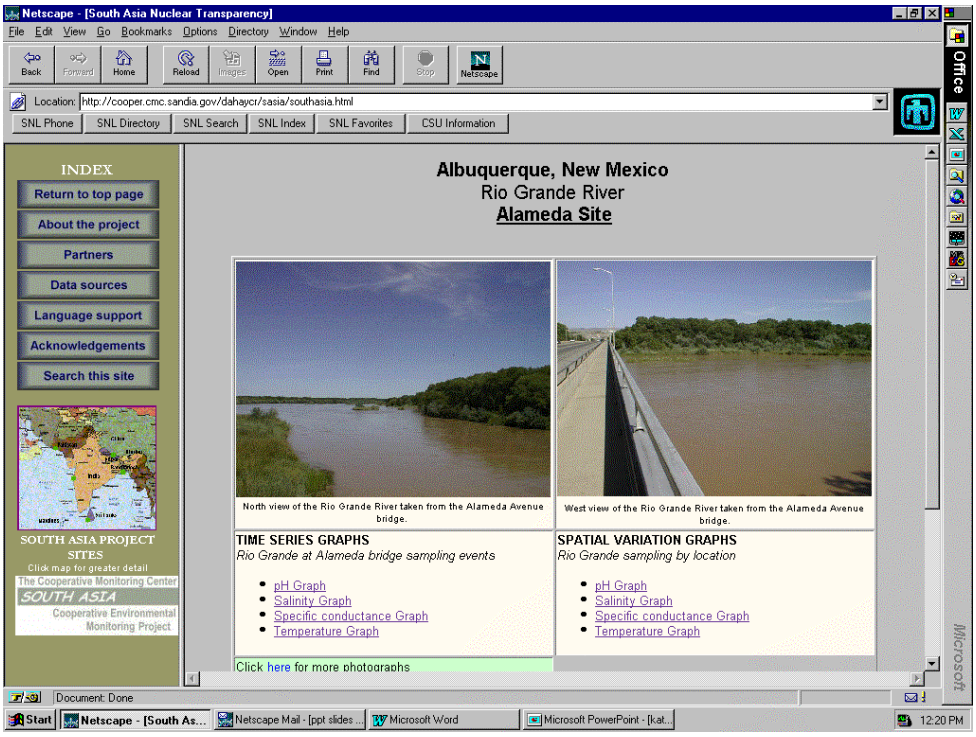

Figure 16. Photographs and Links to Graphs of Temporal and Spatial Variation of Data

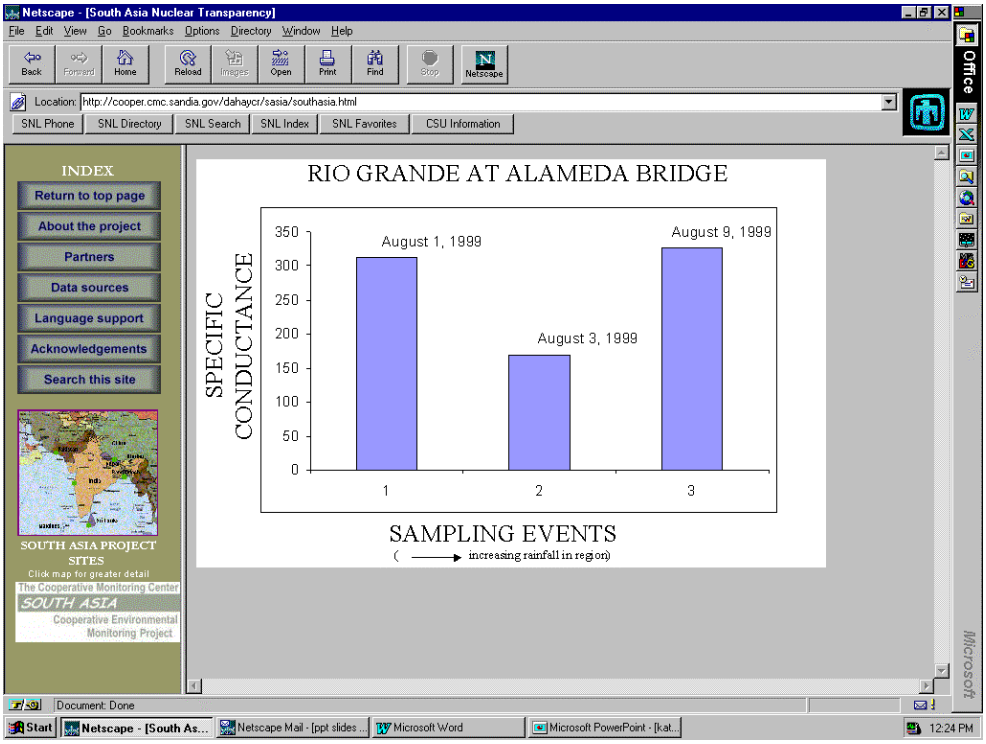

Figure 17. Graphical (and Numeric) Descriptions of Data Collected

4. Discussion and Conclusion

The database being created is unique in its regional focus, and is therefore likely to become an important part of future South Asian water resources studies.

Although presently limited in scope to a few parameters, the proposed studies can potentially complement the use of remote sensing data (aerial and satellite). For example, temperature and salinity data can provide information (known as ground-truth) that can assist in the interpretation of remotely sensed multispectral imagery allowing better spatio-temporal analysis. The sparse data could also be used to validate computer models that predict flow and transport. For example, salinity levels in a coastal estuarine region predicted by a flow model can be compared with the measured observations, and the model improved. Information at non-sampled locations can then be inferred from the model with greater validity.

The monitoring studies that have been initiated in this project are one step towards the large-scale regional and well-coordinated monitoring programs that are needed to fully understand the complex watersheds of South Asia. The approaches cited above can increase the utility of sparse and scattered data being collected. However, 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 purpose of the project network is to demonstrate technology and data-sharing capabilities. Therefore, the focus of the project is to promote a regional water-related data-sharing process, and not simply on the data itself. After the transfer of appropriate technologies and the training of regional participants, it is expected 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 begun during the workshop hopes to expand into a regional, government-led effort.

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Appendix A:
List of Participants in Figure 1

Back Row (L to R):

Dinesh Parekh, president, Thane-elapur Industries Association, Mumbai, India (industry)

Arif Alauddin, managing director, Pakistan Energy and Environmental Management Center, Ministry of Environment, Local Government and Rural Development, Islamabad, Pakistan (government)

William Robert Laitos, U.S. AID, Nepal (U.S. government)

Dipak Gyawali, managing director, Nepal Water Conservation Foundation, Kathmandu, Nepal (NGO)

Ahsan Uddin Ahmad, Director of Environmental Programs, Bangladesh Unnayan Parishad, Dhaka, Bangladesh (NGO)

Nimal Padmasiri, Director of Laboratories, National Water Supplies and Drainage Board, Colombo, Sri Lanka (government)

Kent L. Biringer, Distinguished Member of Technical Staff, CMC, Sandia National Laboratories, (U.S. government)

Tony Carvalho, U.S. AID, Nepal (U.S. government)

Deborah Seligsohn, First Secretary of Environmental Affairs, U.S. Embassy, Nepal (U.S. government)

Gaurav Rajen, Visiting Research Scholar, CMC (U.S. government)

J. David Betsill, Senior Member of Technical Staff, CMC, Sandia National Laboratories (U.S. government)

Front Row (L to R):

Keshari Bajracharya, Nepal Ministry of Hydrology and Meteorology, Kathmandu, Nepal (government)

J.K. Ray, professor, Peace Studies Center, University of Calcutta, and Director, South Asia Research Society, Calcutta, India (academic and NGO)

Ananda R. Joshi, Director-General, South Asia Co-operative Environment Programme (NGO/ semi-government – SACEP is made up of the governments of all South Asian countries)

Shyam Sundar Ranjitkar, irrigation specialist, World Bank, Kathmandu, Nepal (international financial institution)

Drona Ghimire, program manager, World Conservation Union, Kathmandu, Nepal (NGO)

Suresh Raj Chalise, director of Mountain Development Programs, ICIMOD, Kathmandu, Nepal (NGO)

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Appendix B:
Agenda

Cooperative Monitoring Center/American Embassy Kathmandu, Nepal
South Asia Water Resources Workshop II
September 12-14, 1999
Soaltee Crowne Plaza Hotel
Kathmandu, Nepal

Sunday Afternoon, September 12, 1999

Arrival and Welcome

PM	Visitors arrive at the airport
7:00 PM	Welcome dinner/workshop orientation hosted by the CMC (Soaltee Hotel)

Monday, September 13, 1999

Introductions

9:00 AM	Welcome and Introductions—American Embassy representative & Kent Biringer, CMC

Project and Program Summaries

9:30 AM	Cooperative Monitoring Concepts and the South Asia Water Project—*Kent Biringer, CMC*
10:15 AM	Middle East Cooperative Environmental Precedent—*David Betsill, CMC*
11:00 AM	Break
11:15 AM	Regional Environmental Program Summaries (10 minutes each)—*SACEP, SAARC, ICIMOD, IUCN, World Bank*
12:15 PM	Discussion
1:00 PM	Lunch
2:00 PM	Regional Project Partner Presentations (20 minutes each) Organizational summaries Project site descriptions for water quality measurements BUP, NWCF, SARS, Thane-Belapur Industries Assn., PNECC, NWSDB
3:00 PM	Break
3:15 PM	Regional Project Partner Presentations (continued)
4:30 PM	Discussion
5:00 PM	Adjourn
5:30 PM	Reception (hosted by U.S. Embassy)
8:00 PM	Dinner

Tuesday, September 14, 1999

Technology Session

9:00 AM	The Significance of Water Quality Measurements—*David Betsill, CMC*
9:30 AM	YSI Water Quality Sensor Demonstration and Lessons Learned—*Gaurav Rajen, CMC*
10:30 AM	Questions, Answers, and Discussion
11:00 AM	Break

Data Processing Session

11:15 AM	Data Handling and Communications, Website Demonstration—*Gaurav Rajen, CMC*
12:30 PM	Discussion
1:00 PM	Lunch

Next Steps

2:00 PM	Other Potential Cooperative Environmental Projects—*Kent Biringer, CMC*
2:30 PM	Coastal Zone Monitoring Example—*Gaurav Rajen, CMC*
3:00 PM	Break
3:15 PM	Project Discussion (next steps, funding support, issues, assignments)
5:00 PM	Adjourn
7:00 PM	Dinner

Appendix C:
Project Partners

C-1. Active Partners

C-1.1 Bangladesh Unnayan Parishad

The Bangladesh Unnayan Parishad (BUP) is a center for research and action on environment and development. Established in 1980, it is a nonprofit, private organization. It is one of the leading think tanks of Bangladesh. The BUP seeks to promote basic as well as applied and action research on social, economic, cultural, political, and environmental issues relating to the imperatives of development.

BUP's research, studies, and other related activities are organized within the framework of the following three basic thrusts:

- economic and social policy research
- environment and development studies
- social weather analysis

The above three broad themes subsume relevant core areas, including :

- agriculture
- industry
- infrastructure development
- rural development
- poverty alleviation
- social sectors
- environment
- natural resources, including water resources
- sustainable development
- public opinion research

Over the years, BUP has acquired and developed the required expertise for conducting research and studies on projects relating to the listed subjects. Besides professional staff drawn from different appropriate disciplines, BUP maintains a roster of resource personnel and experts as well as field staff who can perform project-specific work. The core full-time professional staff strength at different levels—senior scholars, research directors, senior specialists/fellows, fellows, senior associates, associates—currently stands at 22, besides other administrative and support staff.

Through its Planning Forum, the BUP organizes policy debates, seminars, workshops, symposia, and discussion meetings on pertinent socioeconomic, technological, environmental and other issues relating to development. Conferences/seminars/workshops are a continuous process with

BUP. The main purpose is to disseminate research findings and bring together people of diverse backgrounds to debate policy options and development alternatives.

The BUP has published over a hundred research reports, monographs, compilations of papers and articles, and books on national and regional development issues. The BUP publishes three journals. A Bengali quarterly journal, *Unnayan Bitarka* (Development Dialogue), carries research-based and analytical papers. The monthly *Prodyot* (Glow), also in Bengali, carries short articles on a wide array of subjects, including economic policies and problems, environmental policies and issues, social issues, culture, education, market prices, etc. The third is a biannual journal in English titled *Asia Pacific Journal on Environment and Development*. It focuses on an integrated approach to economic and environmental issues.

C-1.2 South Asia Research Society

The South Asia Research Society (SARS), located in Calcutta, India, is a nonprofit research organization created by retired high-level government officials, industry, and academic personnel. SARS focuses on regional economic development through technological innovation. The SARS is actively involved in governmental and nongovernmental initiatives to promote the efficient use of water resources between Bangladesh, India, and Nepal; as well as other projects ranging from education and social science research to the eradication of rural poverty.

An example of a SARS project is Project Nirdhan (aimed at alleviating the problems of rural poverty), launched in June 1993. The Asia Pacific Development Center (a United Nations affiliate) and the Grameen Trust (an associate of the Grameen Bank of Bangladesh) supplied recoverable grants to SARS for this purpose. Project Nirdhan aims not only at removing poverty through developing the business skills of the rural poor, but also at fostering the holistic development of a community. Project Nirdhan treats the empowerment of women as one of the principal tasks of integrated rural development. In pursuit of such empowerment, Project Nirdhan replicates the Grameen Bank Financial System of Bangladesh, an extraordinary innovation of Professor Muhammad Yunus involving micro-credit and loans to the very poor.

Prof. Jayanta Kumar Ray is the Executive Director of SARS. He is a Centenary Professor of International Relations at the University of Calcutta's Department of History, Peace Studies Group (PSG), and a recognized international expert on issues of regional cooperation and the Ganga River Basin. The PSG provides intellectual support to SARS. The PSG has helped SARS organize two international workshops, leading to two publications: one on India-Bangladesh cooperation, and the other on India-Nepal cooperation.

C-1.3 Thane-Belapur Industries Association

The Thane-Belapur Industries Association (TBIA) represents over 3,000 industries located along the mainland across from the island city of Mumbai, India. The association has established a common effluent treatment plant, one of the first in India, with World Bank assistance. The TBIA is committed to the restoration of Thane Creek (which runs adjacent to their industrial areas) through preventing untreated effluents and non-point-source pollution from reaching the

creek. More rigorous monitoring studies are an essential part of the association's future plans for reducing effluent quantity and toxicity.

C-1.4 Nepal Water Conservation Foundation

The Nepal Water Conservation Foundation (NWCF), located in Kathmandu, Nepal, is a non-profit, nongovernmental research organization dedicated to the interdisciplinary study of water and related issues. The main objectives of the NWCF are to ensure growth and dissemination of scientific knowledge for correct decision making and to promote sustainable development, management, and protection of water. The NWCF pursues these objectives through

- interdisciplinary research and dissemination,
- capacity building and training, and
- water documents repository.

The NWCF provides help to journalists and activists in scientifically researching issues. The organization is known worldwide for its analysis of water-resources-related issues in the Himalayas. The NWCF also supports community groups' small-scale water development activities. For example, rainwater-harvesting techniques are among the options promoted by the NWCF.

The NWCF publishes the biannual scientific journal *WATER NEPAL*, a water development journal. This journal focuses on the study of climate effects, such as cloudbursts, and social vulnerability. Other topics relate to groundwater, micro-hydro, irrigation, and water conflicts. The NWCF also organizes "Pani Satsang," a forum for discussions on issues related on water and its management, and publishes a bulletin of the same name.

Among its many activities, the NWCF is currently involved in a collaborative transboundary study (with Indian NGOs) on the Rohini River that flows from Nepal into India. Activities with a regional focus include establishing the Duryog Nivaran Network, a South Asian network on disaster management. The NWCF also manages a fellowship program for South Asian scholars called the Fellowship on South Asian Alternatives.

C-1.5 Pakistan Energy and Environment Management Center

The Pakistan Energy and Environment Management Center (PEEMAC) is an NGO dedicated to the cause of promoting the efficient use of energy resources and protecting the environment. PEEMAC publishes a quarterly newsletter called *EnvironNews*. PEEMAC works closely and is affiliated with the Pakistan Ministry of Environment, Local Government and Rural Development. An example of a PEEMAC project is a study of the building design of primary schools and health centers with a view to improving ventilation, insulation, lighting, and overall physical comfort. Fuel cells, solar and wind energy, and reducing vehicular air pollution are some other areas of interest to PEEMAC. PEEMAC is developing strategies of pollution control from untreated wastewater and has identified Rawal Lake (near Islamabad and Rawalpindi) as a target

area for further study. In this study of Rawal Lake, the PEEMAC will be working with the following agencies:

- Sustainable Development Policy Institute
- Quaid-i-Azam University, Islamabad
- Pakistan Environmental Protection Agency

C-1.6 National Water Supplies and Drainage Board

The National Water Supplies and Drainage Board (NWS&DB) of Sri Lanka is responsible for the supply of water to Colombo and surrounding areas, serving a population of approximately 1.4 million. The NWS&DB currently operates a remote data acquisition system that collects data from numerous locations on the NWS&DB's water distribution infrastructure. The Kelani River is also monitored at an intake point of the NWS&DB water supply system. The NWS&DB has agreed in principle at this time (pending further review and approvals as needed from various government agencies) to share near-real-time data on the depth of the Kelani river at its water intake point. Data already shared demonstrate clearly the effects of tidal fluctuations at this location. The NWS&DB will also monitor water quality at this same location, and share the data with the project partners. Salinity levels and water depth fluctuation could be very valuable data for validating tidal flow and transport models for the Kelani River estuary.

C-2 Regional Organizations Committed to More Involvement in the Future

C-2.1 South Asia Cooperative Environment Programme

The South Asia Cooperative Environment Programme (SACEP), based in Colombo, Sri Lanka, is an association of eight South Asian countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. SACEP came into existence in February 1981 at a meeting of the Environment Ministers of the member countries with the adoption of the Colombo Declaration and the Articles of Association of SACEP. SACEP became a legal entity in January 1982 after at least three member countries ratified the Articles of Association. Among its many activities, SACEP serves as the secretariat for implementing the South Asian Seas Action Plan[3] that has been developed through a collaborative regional process to implement aspects of the United Nations Convention on the Law of the Sea. SACEP is responsible for implementing the plan. The plan includes strategies for promoting regional and cooperative environmental monitoring and, therefore, represents an excellent opportunity for promoting cooperation in coastal issues.

[3] The formal title of the South Asian Seas Action Plan is the Action Plan for the Protection and Management of the Marine and Coastal Environment of the South Asian Seas Region.

C-2.2 International Center for Integrated Mountain Development

The International Center for Integrated Mountain Development (ICIMOD) is active in Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. This organization's website (www.icimod.org) states, "The International Center for Integrated Mountain Development (ICIMOD) is the first international organization to make a commitment to promoting the development of an economically and environmentally sound mountain ecosystem and improving the quality of life of mountain people. The Center was founded amidst widespread recognition of the alarming environmental degradation of mountain habitats and the consequent increasing impoverishment of mountain communities in the Hindu Kush-Himalayan region. It works mainly at the interface between research and development and acts as a 'knowledge bank' on the Hindu Kush-Himalayas and a facilitator for generating new mountain-specific knowledge of relevance to mountain development. It also attempts to ensure that new knowledge is shared among all relevant institutions, organizations, and individuals in the region."

C-2.3 U.S. Department of State's Regional Environmental Affairs Office, Kathmandu

Recognizing that a single country cannot solve regional environmental issues, the DOS has established regional environmental hubs in designated embassies around the world. The hubs are predicated on the idea that transboundary environmental problems can best be addressed through regional cooperation. Rather than dealing with a single country on environmental issues, the hub officers look almost exclusively at transboundary issues. Hub officers engage with several countries of a region on a particular issue, promoting regional environmental cooperation, sharing of environmental data, and adoption of environmentally sound policies that will benefit all countries in the region. The South Asia Hub office is located in Kathmandu, Nepal. "Central to U.S. policy in South Asia is the objective of improving political stability by engaging and enhancing dialogue with and between the countries of the region." (DOS, 1999) Toward this end, the South Asia Regional Environmental Hub located at the U.S. Embassy in Kathmandu identifies issues and opportunities to promote and improve cooperation on global and regional environmental issues. The South Asian Hub's initial focus is towards:

- regional oil spill response capabilities
- management of coastlines and forests
- clean alternative energies
- air and water pollution

The South Asian Hub recognizes a growing consensus that regional cooperation on the use of the great rivers of South Asia, particularly the Ganges, Brahmaputra, and Indus, will be essential to solving some of the region's environmental problems. The U.S. interest in river development projects in South Asia is to ensure that they proceed in a socially, economically, and environmentally sound manner. The Hub plans to analyze the potential for establishing a regional structure to promote regional water cooperation in South Asia and determine what role, if any, the U.S. should play in it.

Appendix D:
Sample Field Data Form (Filled out by the SARS)

CMC South Asia Water Resource Monitoring Project

Country: India State: West Bengal

Executing Agency: SARS/CED, Calcutta

Report No. 1. November 1, 1999: Station 1, Palta

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET

Stream Name : Ganga	**Location** : Palta	
Station # ___1_____ River Mile 2325 km	**Stream Class :** As per current use classification - Bathing, Drinking Water, Fishing, Industrial use	
Lat. 22° 46′613″ Long 88° 21′178″	**River Basin :** Ganga	
Street #	**Agency :** SARC	
Investigators : A.K. Ghosh, S.C. Santra, A. Danda, S.K. Das, A.C. Samal		
Form Completed By : Team	Date 1/11/99 Time 11.45 Am	Reason for Survey Water quality monitoring

WEATHER CONDITIONS	**Now**	**Past 24 hours**		**Has there been a heavy rain in the last 7 days?** Yes (x) No **Air Temperature** 33°C **Other** _____
			Storm (heavy rain)	
			rain (steady rain)	
		(x)	showers (intermittent)	
	____	_____	%cloud cover	
	(x)		clear/sunny	
SITE LOCATION/ MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)** Photograph and map to be sent separately			
STREAM CHARACTERI-ZATION	**Stream Subsystem** Perennial(x) Intermittent Tidal **Stream Origin** Glacial (x) Spring-fed Non-glacial montane Mixture of origins Swamp and bog Others _____			**Stream Types** Cold water(x) Warm water Catchment Area 861,404 km^2

WATER SHED FEATURES	**Predominant Surrounding Land Use** Forest Commercial Field/Pasture Industrial (x) Agricultural (x) Other _____ Residential (x)	**Local Watershed NPS Pollution** No evidence Some potential sources Obvious sources (x) **Local Watershed Erosion** None Moderate (x) Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant types and record the dominant species present** Trees Shrubs (x) Grasses (x) Herbaceous **Dominant species present** *Acanthus illecifolius, Ipomea fistulosa*	
INSTREAM FEATURES	**Estimated Stream Width** 540 m **Estimated Stream Depth** 12 m **Surface Velocity** NA m/sec **(at thalweg)** **Estimated Reach Length** : 540 m **Canopy Cover** Partly open Partly shaded Shaded Fully open (x)	**High Water Mark** 6 m **Proportion of Reach Represented by Stream Morphology Types** Riffle _____ % Run 100% Pool _____ % **Channelized** Yes No (x) **Dam Present** Yes No (x)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** Rooted emergent Rooted submergent Rooted floating Free floating Floating Algae Attached Algae None (x) **Dominant species present** ____NA_____ **Portion of the reach with aquatic vegetation** _____ %	
WATER QUALITY	**Temperature** 28 ± 1°C **Conductivity** 240 µmhos/cm **Dissolved Oxygen** 8.5 ± 0.1 mg/l **pH** 7.7 ± 0.2 **Salinity :** 0 ppt **WQ Instrument Used** YSI 63	**Water Odors** Normal /None (x) Sewage Petroleum Chemical Fishy Other _____ **Water Surface Oils** Slick Sheen Globs Flecks None(x) Other _____ **Turbidity (if not measured)** Clear Slightly turbid Turbid(x) Opaque Stained
SEDIMENT/ SUBSTRATE	**Odors** Normal(x) Sewage Petroleum Chemical Anaerobic None Other _____ **Oils** Absent(x) Slight Moderate Profuse	**Deposits** Sludge(x) Sawdust Paper fiber Sand Relict shell Others - _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** Yes No(x)

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