WATERWEALTH?

INVESTING IN BASIN MANAGEMENT IN ASIA AND THE PACIFIC

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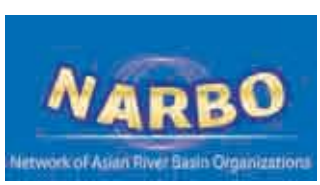
Ganesh Pangare

Binayak Das

Wouter Lincklaen Arriens

Ian Makin



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Coordination: Binayak Das, Lisa Binti Idris and Dennis Von Custodio

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Available from:

IUCN Asia Regional Office
63 Sukhumvit Soi 39
Sukhumvit Road, Wattana
Bangkok 10110
Thailand
Tel: +662 662 4029
Fax: +662 662 4387

Academic Foundation
4772-73/23, Bharat Ram Road
Daryaganj
New Delhi - 110 002
India
Tel: +91 11 2324 5001-04
Fax: +91 11 2324 5005

Asian Development Bank
6 ADB Avenue
Mandaluyong City
1550 Metro Manila
Philippines
Tel: +632 632 5803
Fax: +632 636 2231

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PREFACE

THE IDEA BEHIND this book is to tell a story of hope for the future of our water resources. If we listen with humility, we can learn from the experiences of people in Asia and the Pacific who have found answers, or are on their way to finding them, to the main water challenges we face in this region. The most important learning from these experiences is that if a country wants to achieve economic growth, become energy secure and feed its population, it must find ways to invest wisely in river basin management.

This is the central message we want to give to the ministers of finance and other policy makers who decide where and for what purpose a country invests its resources. Water is the engine that drives both the economy and the society behind it. Water and wealth are connected. Thus, the issue facing decision makers is not what their country will gain by investing in water, but what it will lose if it does not invest in securing its river basins as a matter of priority.

Today, the countries of Asia and the Pacific face some hard development choices. Rising investment and consumption are transforming landscapes and lifestyles across the region. Can the current boom be sustained? We believe it can, but only if we manage one of the main pillars of this growth—water. Asia is in the grip of a water crisis that could set back its robust growth if left unresolved. By 2030, the region is projected to have a gap of up to 40% between the demand for and supply of water.

How can countries manage the interlinked challenges of water, energy and food security? What are some of the proven tools and measures they can use to achieve this goal?

Drawing on a cross-section of 43 case studies prepared specially for this book, *WaterWealth?* explains the challenges to improving water governance and management across Asia and the Pacific region. It illustrates many examples of new approaches and practices already being applied by basin managers to secure water for all. The solutions it presents are local ones—home-grown measures that build on international experience rather than transplants from elsewhere.

We hope that readers will be encouraged to explore the cases in more detail by means of the references provided at the end. A website will be launched at the regional knowledge hub with detailed information about the cases and their implications. In the meantime, readers are invited to contact IUCN and ADB for more information, and to continue the dialogue on better management of our basins now and for the future.

Ganesh Pangare
Binayak Das
Wouter Lincklaen Arriens
Ian Makin

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ACRONYMS

3S	Sesan, Sre Pok and Sekong river basin
4Ps	Prek Preah, Prek Krieng, Prek Kampi and Prek Te river basin
ADB	Asian Development Bank
AIDA	International Association for Water Law
APFaMGS	Andhra Pradesh Farmer-Managed Groundwater Systems Project
APN	Asia–Pacific Network for Global Change Research
BBWS-BS	*Balai Besar Wilayah Sungai Bengawan Solo*
BIRDS	Bharati Integrated Rural Development Society
BLF	Basin Level Federation
BOD	biochemical oxygen demand
BPRBC	Bang Pakong River Basin Committee
CamboWP	Cambodia Water Partnership
CEB	Ceylon Electricity Board
CNMC	Cambodia National Mekong Committee
CNNL	Cauvery Neeravari Nigam Limited
CRBOM	Center for River Basin Organisations and Management
CTJRC	Chu-Talas Joint Rivers Commission
CWRC	Changjiang Water Resources Commission
DALY	Disability-Adjusted Life Year
ECA	ecologically critical area
EHMP	Ecosystem Health Monitoring Programme
EU	European Union
EUFS	Environmental User Fee System
FAO	Food and Agriculture Organisation of the United Nations
GDP	gross domestic product
GEF	Global Environment Facility
GIS	geographic information systems
ICM	Motueka Integrated Catchment Management
IDR	Indonesian Rupiah
IGBP	International Geosphere-Biosphere Programme
INBO	International Network of Basin Organisations
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JWA	Japan Water Agency
KBJNL	Krishna Baghya Jal Nigam Limited
KNNL	Karnataka Neeravari Nigam Limited
LLDA	Laguna Lake Development Authority
LUAS	*Lembaga Urus Air Selangor*
MASL	Mahaweli Authority of Sri Lanka
MDBA	Murray-Darling Basin Authority
MFF	Multitranche Finance Facility
MoMo	Model Region Mongolia

MOU	Memorandum of Understanding
MWRAS	Mekong Water Resources Assistance Strategy
NARBO	Network of Asian River Basin Organisations
NASA	National Aeronautics and Space Administration (United States)
NGO	non-governmental organisation
NSDP	National Strategic Development Plan (Cambodia)
NWI	National Water Initiative (Australia)
NWRB	National Water Resources Board (Philippines)
O&M	operation and maintenance
ORM	Onggi River Movement
OSCE	Organisation for Security and Co-operation in Europe
PDA	pilot and demonstration activity
PES	payments for ecosystem services
PJT I	Jasa Tirta I Public Corporation
PJT II	Jasa Tirta II Public Corporation
PHP	Philippine Peso
PRC	People's Republic of China
RBO	river basin organisation
RRBO	Red Thai Binh River Basin Planning Management Board
SDC	Swiss Agency for Development and Cooperation
SEQ	South East Queensland
SEQRWQMS	SEQ Regional Water Quality Management Strategy
SHG	self-help group
SIWI	Stockholm International Water Institute
SOPAC	South Pacific Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
UKHP	Upper Kotmale Hydropower Project
UMMRL	United Movement of Mongolian Rivers and Lakes
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO-HELP	United Nations Educational, Scientific and Cultural Organisation-Hydrology for the Environment, Life and Policy
USAID	United States Agency for International Development
VND	Vietnamese Dong
WAPDA	Water and Power Development Authority (Pakistan)
WEAP	Water Evaluation and Assessment Programme
WHO	World Health Organisation
WUA	water user association
WWF	World Wide Fund for Nature
YRCC	Yellow River Conservancy Commission

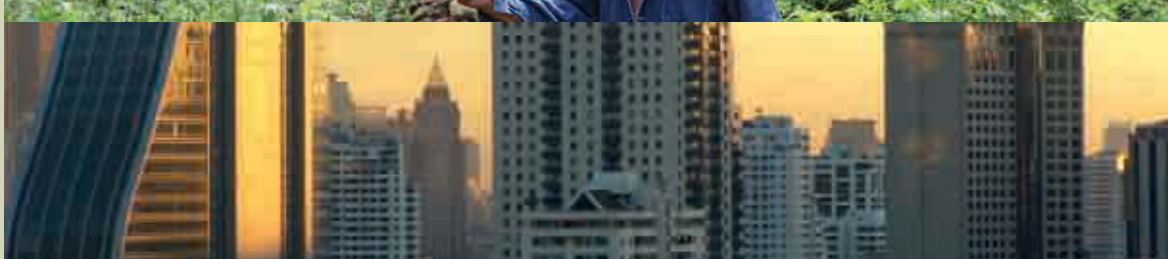
WHAT IS A BASIN?

A basin is the area drained by a river and its tributaries, and is considered the basic unit of water management. Basins contain both surface and underground catchments, which form water bodies such as lakes, streams, springs, wetlands and aquifers.







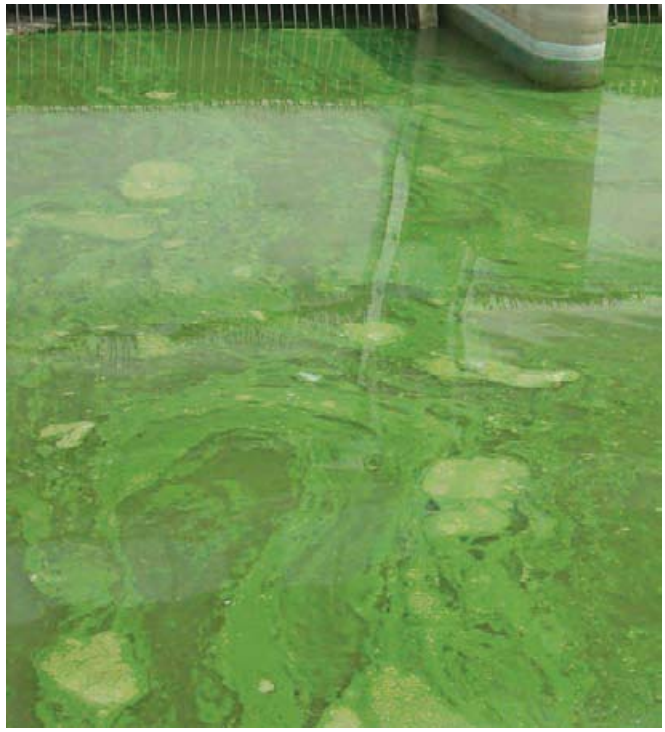




SETTING THE SCENE

A BASIN IS the area drained by a river and its tributaries, and is considered the basic unit of water management. Basins contain both surface and underground catchments, which form water bodies such as lakes, streams, springs, wetlands and aquifers (Falkenmark 2009). These resources support a range of ecosystems and livelihoods, and are used for different purposes and in different ways. A basin supplies water for basic consumption needs and for productive activities such as agriculture, aquaculture, energy generation, manufacturing and industry, and tourism. Depending on the size of the basin, it may include a range of social, cultural, climatic and physical variations. Basins often overlap and cross political boundaries and administrative jurisdictions. Larger basins with a wider range of uses, and a greater diversity of people, cultures and jurisdictions, require more intensive efforts to put in place suitable institutions, policy instruments and management strategies.

Although awareness is growing that water is essential to social and economic growth, decision makers still lack the conviction that investing in sound river basin management will drive economic growth, social development and political stability. So, while river basin resources are exploited for social and economic gain, much less effort is put into improving their resilience to the pressures from human activity. Pollution, declining environmental flows (the water provided to maintain ecosystems and livelihoods), watershed degradation, population growth and climate change are all putting greater stresses on river basin resources and ecosystems. Efforts are urgently needed to protect and restore the health of rivers and the ecosystems they support, and thereby the wealth of the nation.

Investments in river basin management drive economic growth



The challenge of the balance: The People's Republic of China today is the world's second largest economy. Basins featured in this report contribute a large percentage of the gross domestic product (GDP) of the country. The impact of heavy pollution on freshwater supply and public health, as seen in these basins, highlight the critical links between basin management and sustainable economic growth. Clean-up programmes to restore the health of the Songhua and Yellow Rivers and Chao Lake have become examples of innovative policy and practice.

Economic implications

The capacity and productivity of people and economic sectors such as agriculture and industry depend on a secure supply of usable water. At the village level, for example, having access to water for irrigation can make or break a farm household's economy. People's health can be affected by dirty or contaminated water, making them unfit for productive work. Similarly, long hours spent collecting water can limit the productive lives of women.

The livelihoods of poor people, particularly those in rural areas, depend directly on the health of the ecosystems and river basins in which they live. Sustainable rural economies are critical for long-term economic growth, especially in developing countries where the agricultural sector is still the dominant source of wealth.

Although many political and economic factors govern international trade, water availability can have an impact on import and export patterns. Countries with secure water availability are able to export water-intensive goods and services. This trade in "virtual water" — the water embedded in the production of a traded good — is one way of redressing water scarcity between countries and regions.

It is clear that the availability and accessibility of fresh water are important factors in economic growth and development. Those countries which in 1965 had the lowest per capita incomes, yet had access to clean water and sanitation services, safe housing, medical care and other health requirements, grew at an average rate of 3.7% per year to 1994. By contrast, countries in the same income bracket but with poorer health conditions grew at only 0.1% per year in the same period (Sachs 2001).

As water becomes scarcer, whether because of natural causes or mismanagement of water resources, competition for water among different sectors intensifies, putting strain on water tariffs and other pricing mechanisms. Higher costs for energy, well drilling, pumping and water transport affect the economy at all levels from the household to the macro level. Economic growth as a whole can slow, pushing up insurance and credit costs, and lowering investor confidence and business profits.

The World Health Organisation (WHO) uses disability-adjusted life years, or DALYs, to quantify the overall burden of disease. These incorporate measures of both mortality and morbidity, that is, the incidence of poor health or disability. One DALY can be thought of as one lost year of "healthy" life (WHO 2008). Water deficits, including inadequate sanitation and effluent disposal, account for nearly 40% of all DALYs lost worldwide, and the impact of water scarcity and poor water management on health is greatest in developing countries such as the People's Republic of China (PRC), which loses 7 million DALYs each year, and India, which loses 22.5 million (Lvovsky 2001; Murray and Lopez 1996). Converted into treatment costs, lost productive time and reduced income, water-related ill health is a clear threat to sustained economic growth and stability, and to reducing poverty.

Managing river basins

Although the links between secure access to water and the efficient management of water resources are well-established, investment in river basin management has failed to keep up with the state of knowledge. Countries still prefer to invest in "hardware" such as dams and canals, rather than "software" such as watershed management systems, research and policy, environmental standards, monitoring, training and

public education. Such actions do not necessarily require large financial outlays, but rather an investment in human capital, cooperation and leadership. Relatively inexpensive solutions such as education, behavioural change, capacity development, and policy and planning tools, can lead to large improvements in the health of rivers and river basins.

If managed efficiently and equitably, common property resources such as lakes, rivers, groundwater and wetlands can produce more food and income for the poor. It is necessary, however, to ensure that management practices do not unfairly restrict access to these resources, nor have a negative impact on ecosystems. For example, water storage structures such as dams can mitigate the effects of water shortages on agriculture and industry. But such resources should not be allocated purely on the basis of ability to pay. If they are, industries could take away much-needed water from livelihood activities such as farming and fishing, undermining economic growth and stability in the long run.

Individuals, businesses and governments often share water-related risks, even if they evaluate them differently. Hence, a cross-sectoral and multi-stakeholder approach to governance is needed to manage river basins effectively. Outdated public policies and weak water management institutions increase the risks for everyone. Common principles for effective water management should include: a focus on long-term sustainability; prioritizing water allocation to those least able to cope with scarcity; maintaining flexibility in the face of changing climatic and hydrologic regimes; and emphasizing integrated policies, responsive institutions and broader stakeholder engagement.

Future challenges

The challenge we face is to strengthen the resilience of river basins to shocks and stresses, while also feeding growing populations, adapting to climate change, ensuring energy security, and sustaining poverty reduction and economic growth. Innovative and workable solutions are needed to achieve these goals. Resilience is the inherent potential of the river ecosystem to mitigate impacts and disturbances to the functioning of the system (ADB 2012). A river basin can be considered resilient when forests, soils, wetlands, floodplains form a natural infrastructure that stores water, regulates flows and maintains the hydrologic balance. If human intervention is to support this resilience, water development projects must combine natural with built infrastructure, ensuring both are managed adaptively, reduce river fragmentation, and meet environmental flow requirements.

A basin cannot stay resilient if the people living in and interacting with it are not also resilient. So another requirement is a diversified economy which gives people a range of livelihood options for responding to changes in their environment. Also vital is empowering people to take part in the governance of basin resources and ecosystems through participatory institutions that meld adaptability with the capacity to generate and use local information, knowledge and skills. Lastly, supportive water laws and policies are needed to foster innovation and adapt best practices to changing local needs.

The actions we take now to reform and reinvent water policy, and the choices we make regarding our water resources, will determine our ability, and our likely success or failure, in meeting future challenges in sustaining social and economic growth. ■

Livelihood for all: **These pictures are of fishermen from Bangladesh (left) and Japan (right). Their livelihood is dependent on fishing, for which healthy rivers with abundant fish are necessary. The issues of livelihood, clean water to maintain ecosystems and life are the same, be it Japan or Bangladesh.**

LEARNING FROM THE GROUND

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
			
CENTRAL AND WEST ASIA Kazakhstan and the Kyrgyz Republic			
Chu-Talas River Basin (115,200)	Irrigation, mining, acquaculture, livestock, hydropower, and natural breeding habitat for fowl	• Water allocation and distribution • Joint management of the river basins • Safe and reliable operation of water distribution facilities • Maintenance of environmental flows	Bilateral Framework Agreement of 2000 between Kazakhstan and the Kyrgyz Republic for better cooperation. Establishment of the Chu-Talas Joint River Commission. Investment by downstream country (Kazakhstan) in operation and maintenance (O&M) of infrastructure in the upstream Kyrgyz Republic for mutual benefit.
SOUTH ASIA Pakistan			
Indus River Basin (1,165,000)	Irrigation, hydropower, and domestic use	• Floods and droughts • Water allocation between provinces • Water allocation between Pakistan and India	The Indus Water Treaty between India and Pakistan led to the establishment of the Indus Water Commission for water allocation between India and Pakistan. Within Pakistan, the Indus River System Authority is responsible for management and allocation of water to the provinces.
Balochistan Groundwater Basin	Dryland farming, grazing, and irrigation	• Drought • Breakdown of traditional water harvesting and management systems	With donor support, the provincial government is helping to rehabilitate the *karez* system of accessing groundwater. The *karez* are resilient drought proofing systems.
SOUTH ASIA India			
Gagas River Basin (500)	Agriculture, and horticulture	• Deforestation • Maintaining environmental flows • Availability of water	With donor support and community contribution, catchments are being protected, infiltration wells are being installed, and springs are being revived.
Krishna-Cauvery River Basin (153,155)	Hydropower, agriculture, and industry	• Low water flow during dry season leading to conflicts among riparian states • Reduced environmental flows	An autonomous corporation has been set up by the state to modernize the irrigation system for greater efficiency in water use.
Andhra Pradesh Groundwater Basin	Agriculture	• Groundwater depletion • Drought	With donor support and community contribution, a groundwater management project invested in capacity development of farmers to manage groundwater effectively and efficiently through crop water budgeting.

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
SOUTH ASIA Bangladesh			
Tanguar Haor Wetlands (9,727)	Fisheries, sand mining, and important breeding ground for migratory birds	• Protection of fish and bird habitat • Protecting traditional methods of fishing	Strengthened community management of wetland and secured traditional fishing rights.
SOUTH ASIA Sri Lanka			
Mahaweli River Basin (10,000)	Irrigation, agriculture, and hydropower	• Fragmented sectoral management • Lack of environmental concerns	Institutional reforms and capacity building to make management more efficient. O&M arrangement with farmer organizations. Service delivery handed to line agencies. Mobilizing stakeholders and promoting participation.
Kotmale River Basin (585)	Hydropower, tourism, and tea plantations	• Waterfalls and biodiversity in the basins were affected by hydropower projects	Environmental Impact Assessment (EIA) suggestions were incorporated through a transparent process. A comprehensive water management plan was prepared and implemented by the Ceylon Electricity Board and displaced people were resettled.
EAST ASIA People's Republic of China			
Yellow River Basin (742,443)	Mining, agriculture, grazing, hydropower, domestic use	• High rate of sedimentation • Flooding • Loss of forest cover • Pollution • Increasing water demand	The Yellow River Conservancy Commission was constituted for overall management of the basin. Land use management was improved by regenerating forests, control of grazing, vegetation regeneration. Sedimentation was controlled and flooding reduced.
Tarim River Basin (557,000)	Irrigation (cottons, grain, and fruit)	• Shallow water tables • Soil salinity • Maintaining environmental flows	The Tarim Basin Water Resources Commission has introduced a quota system to reduce water allocation for irrigated agriculture, improved farming systems, lined irrigation canals, introduced water tariffs based on volumetric basis and reallocated water for environmental flows.
Yangtze River Basin (1,800,000)	Domestic use, hydropower, biodiversity, fisheries, inland navigation, and wetlands reserves and tourism	• Loss of forest cover • Pollution • Fragmentation of bird habitats and endangering the Yangtze dolphin • Floodplains reduced in area	Under the Water Law 2002, the Changjiang Water Resources Commission was established for integrated planning and management of the basin including wetlands restoration for biodiversity, sustainable use of wetlands for income generation, and curtailing use of chemical fertilizer and pesticides with farmer participation.
Miyun Watershed (15,788)	Agriculture, and domestic use	• Contamination of reservoir and watershed from pollution	A compensation fund created to encourage the participation of local farmers in regenerating the forests and protecting the catchment area. Farmers took upon themselves the responsibility for guarding the forest and watershed.
Chao Lake Basin (13,350)	Agriculture, domestic water for cities, industry, fisheries, navigation, tourism	• Pollution • Effective cross-jurisdictional management system	An integrated management authority for Chao Lake in Anhui Province was created in 2011. The authority's comprehensive mandate includes land use planning, water quality and quantity issues, fisheries, navigation, and tourism.
Songhua River Basin (557,000)	Agriculture, domestic water for cities, industry	• Pollution	Basin-wide technical and institutional analyses, supported by a concerted investment programme, helped to reduce water pollution, protect water resources, address water shortages through recycling effluent, and control non-point source pollution through effective solid waste management.

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
			
EAST ASIA Mongolia			
Onggi River Basin (52,920)	Grazing, and mining	• Major water contamination from mining • Diversion and reduction of flows	The Onggi River Movement is a people's movement that lobbied the government to stop mining in the basin area. United Movement of Mongolian Rivers and Lakes has forced the government to pass a law that bans mining in headwaters of rivers, and protects the catchments of water reservoirs and forest regions.
Onon River Basin (94,010)	Agriculture, biodiversity, tourism	• Environmental degradation	Environmentally-focused community-based organisations were formed. Local government capacities were strengthened to effectively implement natural resources management policies. Establishment of the Onon River Basin Council.
EAST ASIA Japan			
Yoshino River Basin (3,750)	Irrigation, urbanization, hydropower, and local tourism	• Floods and earthquakes • Allocation of water between different users	Multistakeholder working group formed to reallocate water for different uses. Established a drought conciliation mechanism, and mechanism for ensuring water for the environment.
Tama River Basin (1,240)	Agriculture, industry, hydropower, and domestic use	• Floods • Deterioration of water quality	The Tama River Citizen's Forum was established and through public participation, a river improvement plan was prepared. The riverside now has a cultural, social and tourist space. Flooding and pollution have been controlled.
Tsurumi River Basin (235)	Domestic use, industry and sports and recreation	• Flooding and urbanization • Traditional flood control measures cannot be implemented due to land constraint	Land utilized for sports arena, recreation area, and natural park, designed in a way that increased flood retention capacity and reduced cost of flood control measures.
EAST ASIA Republic of Korea			
Nakdong River Basin (23,800)	Urbanization, hydropower, and industry	• Pollution from upstream • High wastewater treatment costs	A water user fee was introduced and the revenue collected from industry, hydropower generation, and water supply utilities was used to create a River Basin Management Fund for protecting upstream sources and controlling pollution from domestic waste and textile industries.
SOUTHEAST ASIA Thailand			
Yom River Basin (23,616)	Agriculture, and fisheries	• Floods • Water quality • Environmental concerns • Dispute between water users	The Yom River Basin Working Group was formed and a Memorandum of Understanding (MOU) was signed between upstream and downstream sub-districts to control water quality. A Data Collection and Information Centre was established.

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
Bang Pakong River Basin (7,978)	Agro-forestry, agriculture, fisheries, livestock, and industry	• Floods and erosion • Soil degradation • Water allocation • Water pollution	Bang Pakong River Basin Committee formed and a dialogue initiated among stakeholders for water allocation. Information generation and management system was created with the participation of local farmers.
Na Kha River Basin (8,825)	Export of water lily to Europe and Singapore, domestic use, agriculture, fisheries, and stone and soil mining	• Water quality • Conservation of endangered water lily • Erosion of river bank	Conservation group set up of local people with support from IUCN to monitor water quality and conserve the water lily. The Thailand government recognized the water lily as one of the ten most endangered species.
SOUTHEAST ASIA Lao PDR, Cambodia, Viet Nam			
3S River Basin (78,650)	Fisheries, agro-forestry, and hydropower	• Poverty • Environmental concerns	A transboundary Integrated Water Resources Management (IWRM) project has been initiated by the three riparian countries — Lao PDR, Cambodia and Viet Nam. The Sre Pok sub-basin established a river basin organization (RBO) in 2006 through a bottom-up process. Sesan committees were established in Cambodia and Viet Nam to coordinate studies and information exchange within the basin.
SOUTHEAST ASIA Viet Nam			
Red River Basin (169,020)	Fisheries, industry, agriculture, and domestic use	• Reduction in flows • Water quality • Sedimentation • Water sharing issues between provinces	Management at local sub-basin level showed better results and solved water sharing issues. Legal arrangements enhanced the IWRM process and led to the formulation of the Red River Basin Integrated Water Resources Use and Protection Plan in 2007.
Dong Nai River Basin (38,600)	Hydropower, fisheries, agriculture, domestic use, and industry	• Wastewater runoff from agriculture, industries, and aquaculture • Clean water not available for cities • Hydropower	Water and hydroelectric companies pay fees to the government to use clean water under the Payment for Ecosystem Services (PES) system; revenue is shared by the government, forest protection boards, and communities for forest protection and promoting non-polluting farming practices.
SOUTHEAST ASIA Cambodia			
4Ps River Basin (12,472)	Agriculture, plantations, and biodiversity	• Poverty • Flood and drought	Functional Water Partnership set up for implementing IWRM with stakeholder participation. Project included poverty alleviation and environment protection.
SOUTHEAST ASIA Thailand, Cambodia, Lao PDR, Viet Nam			
Mekong River Basin (795,000)	Fisheries, biodiversity, hydropower, irrigation, and navigation	• Pollution • Water allocation • Drought and floods • Environmental flows	An inter-governmental institution, the Mekong River Commission provides a structure for mutual cooperation among member states.
SOUTHEAST ASIA Philippines			
Laguna Lake (900)	Fisheries, irrigation, industry, domestic use, recreational activities, and hydropower	• Discharge of untreated waste water into the lake	Laguna Lake Development Authority administers the Environmental User Fee System (EUFS) to all industries, housing subdivisions, and commercial establishments discharging wastewater to the lake. The EUFS consists of a fixed administration fee and a variable fee determined by the biochemical oxygen demand (BOD) load discharged into the lake.

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
			
Davao River Basin (1,800)	Raw material for food, and medicine and cosmetics	• Pollution in the river • Inadequate flows • Numerous local initiatives undertaken by different organisations without coordination	Watershed Code was enacted in 2007 with the purpose of integrating fragmented schemes being implemented in the basin. Watershed Youth Management Council was formed; UNESCO-HELP Davao Network helped to resolve local conflicts.
SOUTHEAST ASIA Malaysia			
Kinabatangan River Basin (16,800)	Palm oil, agriculture, biodiversity, fisheries and tourism	• Replacement of rainforests with cash crops led to major biodiversity losses • Flooding	Wildlife conservationists, plantation owners, villages and the government came together to create a habitat for wildlife. Forest area was delineated and protected for conservation. Plantations gave up land for conservation purposes.
Langat River Basin (2,938)	Agriculture, navigation, industry, and domestic use	• Water scarcity • Water allocation • Pollution • Sectoral management	Langat Basin Management Authority was established. It now works through a multi-stakeholder task force to implement pollution control measures. Information technology has been appropriately used for mapping land use changes.
SOUTHEAST ASIA Singapore			
Kallang River Basin (4)	Urbanization, navigation, and sports activities	• Limited water availability • Water quality	The government of Singapore initiated a Clean River Project which includes environmental monitoring efforts and relocation of polluting units. The project successfully improved water quality. Public has been educated through awareness campaigns.
SOUTHEAST ASIA Indonesia			
Citarum River Basin (13,000)	Domestic use, industry, hydropower, and agriculture	• Pressure from rapid urban, agricultural and industrial development • Waste management	The government of Indonesia introduced regulations and monitoring of water quality. Strategic Framework for IWRM and road map developed with 50% participation of local communities, funded through a Multitranche Finance Facility (MFF) by ADB.
Bengawan Solo River Basin (16,100)	Irrigation, farmland, and flood control	• Lack of proper coordination among stakeholders across provinces • Water conservation • Floods and landslides • Over-exploitation of water	The Water Council of Bengawan Solo was set up to improve coordination and management. It is one of the first multi-stakeholder platforms set up for basin management in Indonesia with representatives from the national, provincial, and sub-basin levels.
Brantas River Basin (11,800)	Forestry, plantation, agriculture, and homestead	• Water quality degradation • Rapid population growth • Industrialization	A monitoring system has been established where stakeholder reporting, water quality monitoring and routine inspection are carried out. The East Java Provincial government is implementing a clean monitoring programme with non-governmental organisations (NGOs), local communities and media, applying social pressure on industries for pollution control.

BASIN (Area in km^2)	Major Productive Uses	Challenges	Responses
OCEANIA Australia			
Murray-Darling River Basin (106,469)	Agriculture, fisheries, and industry	• Drought • Water availability for domestic use • Reduced environmental flows	The Murray-Darling Basin Authority released a plan in October 2010 that aims to restore environmental flows by diverting water from irrigation and other uses.
South East Queensland Basin (22,672)	Agriculture, fisheries, and industry	• Pollution • Destruction of ecosystems	South East Queensland Healthy Waterways Partnership set up the Ecosystem Health Monitoring Programme which releases an Annual Report Card for its waterways, grading them from A (excellent) to F (fail).
Yarra River Basin (4,078)	Agriculture and fisheries	• Over-extraction of water • Reduced flows	An 18-year newspaper campaign helped to restore river flows.
OCEANIA Pacific Islands			
Republic of Marshall Islands	Groundwater for drinking, irrigation, and lifeline resources	• Pollution of freshwater for drinking • Impact of freshwater on coastal ecosystems including reefs and lagoons • Traditional land ownership • Rights of use	Novel methods of water catchment (runways and rainwater harvesting) and water treatment systems were introduced to reduce pollution.
Palau (487)	Agriculture and fisheries	• Soil erosion • Sedimentation • Nutrient, fertilizer and pesticide pollution • Solid waste disposal eventually ends up in the marine environment • Invasive species • Loss of wildlife habitat	The Government of Palau along with local communities and civil society is focusing on managing the Ngerikil watershed by controlling land degradation, preserving soil stability and reducing agricultural run-off in order to preserve natural habitats and the marine environment.
Solomon Islands (28,400)	Forestry and mining	• Water quality and quantity, slash and burn farming	"Education for Sustainable River and Water Conservation" is an education programme implemented to raise awareness on water management in two river basins in the Solomon Islands.
Vanuatu (12,281)	Livestock rearing, horticulture, and fisheries	• Limited water availability	"Education for Sustainable River and Water Conservation" is an education programme implemented to raise awareness on water management in two river basins in Vanuatu.
OCEANIA New Zealand			
Motueka River Basin (2,170)	Fisheries, aquaculture, recreation, agriculture, and commercial forestry	• Conflicts between water users, especially forestry and agricultural sectors • Allocation of surface and groundwater • Declining water quality and impacts of the catchment discharge into the coastal zone • Loss of flora and fauna and the spread of plant and animal pests	The Motueka Integrated Catchment Management programme engaged the council and local communities in collaborative learning and action research approaches to conflict resolution and sustainable catchment management.

CASE STUDIES

Kazakhstan
The Kyrgyz Republic
Pakistan
India
Bangladesh
Sri Lanka
People's Republic of China
Mongolia
Japan
Republic of Korea
Thailand
Socialist Republic of Viet Nam
Cambodia
Philippines
Malaysia
Singapore
Indonesia
Australia
Pacific Islands
New Zealand

EMERGING ISSUES

- Meeting Rising Demands
- Managing Disater Risk
- Reducing Water Pollution
- Conserving Water Resources
- Increasing Water Efficiencies
- Improving Basin Governance
- Managing Water-Food-Energy Nexus
- Ensuring Equity
- Supporting Human Livelihoods
- Adapting to Climate Change
- Restoring Healthy Rivers
- Conserving Biodiversity
- Valuing Ecosystem Services
- Building a Green Economy
- Improving Energy Efficiency
- Managing Water Allocation
- Sharing Benefits
- Reducing Conflicts
- Using Cutural Space
- Building Community Resilience

Tama

Yoshino Tsurumi

Palau

Marshall Islands

Solomon Islands

Vanuatu

South East Queensland

Murray-Darling

Yarra

Motueka









Cooperation and joint management of shared basins and water resources are crucial to socio-economic development in Central Asia

KAZAKHSTAN & THE KYRGYZ REPUBLIC

CENTRAL ASIA HAS depended on its water and land resources for livelihood and economic growth since time immemorial. However, irrigated farming and livestock production, are now putting great stresses on its fragile ecology. Since most river basins in Central Asia straddle country boundaries, cooperation and agreement between riparian neighbors on allocating water are crucial to the region's continued development. Several multilateral and bilateral initiatives have sought to promote regional growth by fostering water allocation agreements between the five Central Asian countries of Kazakhstan, the Kyrgyz Republic, Turkmenistan, Tajikistan and Uzbekistan (Demydenko 2004). These agreements aim to set well-defined limits on water withdrawals from the region's river basins, taking into account their ecological needs, and to allocate water resources among countries fairly and rationally.

Chu-Talas River Basin

The adjoining basins of the Chu and Talas rivers, shared by Kazakhstan and the Kyrgyz Republic, lie on the northern side of the Tian Shan mountains at an altitude of 500–2,400 m. Covering 115,200 km^2, they support a combined population of more than 1.6 million, and are crucial sources of water for agriculture, aquaculture, power generation, industry and domestic consumption in both countries.

More than 90% of the flow of the rivers is diverted along its course, chiefly for irrigation. The Kirov reservoir, situated in the Kyrgyz Republic close to the border with Kazakhstan, is the only structure on the Talas river regulating the flow of water (Chu Talas Joint River

Shared water resources infrastructure promotes cooperation and economic development

Commission, CTJRC 2007). When water is abundant, it is diverted and allocated for different uses within the basin. The southern plains of the basin are densely irrigated. In downstream areas, where there is less water for irrigation, livestock rearing is the main agricultural activity.

Water relations in the Chu-Talas Basin are governed nationally by the Water Codes of Kazakhstan (adopted on 9 July 2003) and the Kyrgyz Republic (adopted on 5 January 2005). At the regional level, the two countries reached a formal agreement in 2000 on the use of interstate water facilities in the basin. This called for a joint commission to oversee these facilities, which was subsequently inaugurated in Bishkek on 26 July 2006 (Wegerich 2008). The purpose of the CTJRC, as it is known, is:

"To ensure safe and reliable operation of interstate water facilities … [by defining] operational regimes and determin[ing] the volumes of necessary operational and maintenance expenditures." (ADB 2007)

The tasks of the Commission include the following:

- assess and forecast the conditions of water facilities and regulate water use;
- endorse norms and procedures for allocating and using water, and for organizing and financing operation and maintenance (O&M) activities;
- agree on the operational regimes of reservoirs, and adjust water use limits depending on water availability and user needs;
- develop procedures for joint action in emergencies (floods and other natural disasters);
- organize the exchange of hydrologic forecasts and other relevant data and information;
- agree on and coordinate a basin-wide water monitoring and accounting system; and
- organize joint studies to support O&M and the regulation and rational use of basin water resources.

Several donors have helped to finance implementation of the water sharing agreement between Kazakhstan and the Kyrgyz Republic. The European Union, for example, has supported a project for integrated water resources management (IWRM) in the Chu-Talas Basin, while the ADB has helped to set up the secretariat of the Joint Commission, upgrade irrigation infrastructure in the basin, and establish four bilateral working groups on laws and institutions, water allocation, maintenance of irrigation facilities, and monitoring and data exchange (ADB 2006). The United Nations Development Programme (UNDP) is helping to disseminate information. Other support has come from the UN Economic Commission for Europe (UNECE), UN Economic and Social Commission for Asia and the Pacific (UNESCAP), and Organization for Security and Co-operation in Europe (OSCE).

The most interesting aspect of the bilateral agreement between Kazakhstan and the Kyrgyz Republic is the arrangement for O&M. Under this, Kazakhstan bears the cost of repairing and maintaining facilities in both countries because the Kyrgyz Republic lacks the resources for O&M of its infrastructure. Between 1996 and 2007, Kazakhstan provided about US$2.8 million for repair and O&M in the basin (Abdukayumov 2008). ■

Pakistan's draft National Water Policy of 2006 emphasizes an integrated and comprehensive water management strategy

PAKISTAN

AGRICULTURE IS THE backbone of the Pakistani economy and consumes most of this arid country's limited water resources. Yet water is increasingly needed and demanded in other sectors, such as industry, power generation, and urban development. These competing demands are putting great stress on Pakistan's limited freshwater resources.

Pakistan's water challenges are critical. Excessive and unmonitored mining of groundwater for irrigation and consumption has lowered the water table in many parts of the country. Salt water intrusion into aquifers has also reduced the availability of fresh groundwater for drinking and domestic use. The indiscriminate and unplanned disposal of effluents from farming, industry and sewage into freshwater bodies has reduced water quality and pushed up the incidence of water-borne diseases. With per capita water availability in decline, Pakistan will soon become a water-scarce country if it does not manage its remaining resources wisely and efficiently (Ahmad 2008).

The Pakistani government's Water and Power Development Authority (WAPDA) is responsible for managing river basins in the country. Water management is fragmented, however, because it is a provincial responsibility. The draft National Water Policy of 2006 has emphasized the need for an integrated and comprehensive management strategy. The draft policy is still to be debated by policy makers especially in relation to the section on dams (Ahmad 2008).

Indus River Basin

The Indus River is a transboundary river which flows from Tibet through India and Pakistan to the Arabian Sea. The Indus Water Treaty, signed by India and Pakistan in 1960,

led to the establishment of the Indus Water Commission. The treaty allocated the exclusive use of the western rivers of Punjab (Indus, Jhelum and Chenab Rivers) to Pakistan and the exclusive use of the eastern rivers (Ravi, Sutlej and Beas) to India. For over 50 years, it has been an exemplar of sharing transboundary water resources.

The Indus River is the lifeblood of Pakistan. Flowing through four provinces, it is the longest and largest river in the country. Two-thirds of the water used in Pakistan for irrigation or domestic consumption comes from the Indus and its associated rivers. The Indus Basin Irrigation System is the largest contiguous irrigation system in the world covering 14 million ha of irrigated land while the total length of the canals is about 61,000 km (Anon 2008).

Irrigation water from the Indus is allocated to provinces as Canal Water Entitlements based on the Pakistan Water Apportionment Accord of 1991. This distributes water among the different provinces according to average water availability (Government of Pakistan 1991).

The Indus River System Authority is responsible for measuring river flows and canal diversions, and is supported by WAPDA in managing the system. It also ensures that water shortages are shared fairly as well as water entitlements. This can prove challenging as the amount of water available is substantially less than the entitlements agreed under the 1991 Water Apportionment Accord. The construction of dams for irrigation and hydropower, and the irrigation infrastructure itself, have reduced the flow of the Indus River and degraded basin ecosystems. Nevertheless the Pakistan government plans to build five more river development projects by 2016.

The Indus river basin is a multi-layered transboundary basin shared internally between provinces and internationally with India

Groundwater basin of Balochistan

The *karez,* or *qanat* system of tapping groundwater is widely used in the arid mountainous and desert regions of Central and Western Asia. This ancient system comprises a series of vertical wells and a horizontal underground channel (the *karez*) that uses gravity to transport groundwater from upland areas to the surface at lower levels. *Karez* were once common in the arid, mountainous province of Balochistan. During droughts, they tended to be more resilient and less prone to drying up than wells since they suffered fewer losses from seepage and evaporation. In the past 40 years, however, the use of *karez* has dwindled with the indiscriminate sinking of deep tube wells that have reduced the flow of groundwater.

To control and manage the abstraction of groundwater in Balochistan, the provincial government identified and designated groundwater basins for which a specific policy was needed. The resulting policy — Balochistan Groundwater Rights Administration Ordinance of 1978 has proved an effective mechanism for regulating and managing groundwater in these basins. It recognizes both traditional and modern water rights, and provides for managing traditional (*karez*) and modern (tube wells) water systems in a coordinated manner (Anon 2000).

The provincial Department of Irrigation and Power in Balochistan is rehabilitating some of the *karez* systems, upgrading their water galleries to reduce conveyance losses and lining water channels. Local NGOs and IUCN are also helping to rehabilitate some of these systems. ■

The *karez* are resilient systems; they can withstand drought by abstracting from aquifers slowly

Partnerships between communities, the government, and civil society organizations can be effective in managing water resources

INDIA

INDIA HAS 12 major river basins and innumerable smaller rivers and streams. The Ganges-Brahmaputra and Indus river systems are the largest of the major basins, draining almost half of the country and carrying more than 40% of the usable surface water that flows from the Himalayan watershed to the Indian Ocean. The flow in India's rivers is strongly influenced by the monsoon climate. During the monsoon season most rivers reach their peak flow, and the major rivers flood. The northern rivers that rise in the Himalayas see another peak in the spring snowmelt. During the dry season, the flow in most large rivers diminishes and often disappears entirely in smaller tributaries and streams.

India has the second-highest annual rainfall in the world, averaging about 1,150 mm, and ranks among the top ten water-rich countries. Precipitation in the form of rain and snow supplies over 4,000 km^3 of fresh water to India, most of which returns to the ocean via large rivers. Owing to topographic constraints, adverse patterns of distribution, technical limitations, increasing pollution and poor management, India is unable to realize the full potential of its rich water resources (Pangare *et al*. 2006).

Figures from the National Commission for Integrated Water Resources Development show that India uses about 83% of its available water supply for irrigation and the rest for domestic consumption, industry and other purposes. With the country's growing population, urbanization and industrialization, the demand for water is mounting, putting great stress on its water resources.

India's National Water Policy of 2002 emphasizes the need to conserve water resources through efficient use and greater public awareness. Conservation methods such as rainwater harvesting, and unconventional methods for supplying water such as artificial recharging of groundwater and desalination, have been advocated. Greater importance is being given to public participation in water resource management, partnerships with the private sector, and research. In terms of water allocation, the drinking water needs of humans and animals have been given highest priority, followed by irrigation, hydropower, environmental needs, agro-industries and non-agricultural industries, navigation and other uses (Pangare *et al*. 2006).

Under India's Constitution, water is considered a "state subject", which means that states have exclusive authority to legislate on water supplies, irrigation, canals and hydropower. Each state prepares a water policy in line with the principles and objectives of the National Water Policy. Water sharing and allocation among states are guided by the overall availability of water resources at the national level and the needs within the river basins. The Interstate River Basin Authority set up by the federal government under the River Boards Act of 1956, and the Tribunals formed under the Interstate Water Disputes Act of 1956, are responsible for interstate coordination and conflict resolution.

With the increasing importance being given to public participation and community management of water resources in India, various innovative projects and strategies are being launched in the fields of participatory irrigation management, community-based watershed management, and groundwater management.

Gagas River Basin

The basin of the Gagas River, a fragile spring-fed river in Almora district of Uttarakhand, includes 14 major streams and supports over 120,000 people in 350 villages. Over the past few decades, the headwaters and most of the catchment areas in the basin have been denuded of their tree cover, leading to a marked reduction in water flows. River fish no longer form part of the local diet, and agricultural production has declined. An appraisal of the primary water resources of 30 villages in the Gagas basin conducted by Grassroots, a local non-governmental organisation (NGO), found that 124 out of a total of 200 springs had dried up entirely. During the summer season, water shortages in the basin provoke conflicts between the communities who live there (Grassroots 2010).

In 2006-07, Grassroots launched an initiative to restore the Gagas River with support from UNESCO-HELP. The

Farmer participation in water management can increase productivity

Farmers discuss crop water budget before a sowing season

project included the creation of a multi-stakeholder platform in the basin, preparation and implementation of an IWRM strategy, and capacity building.

Working with local communities, Grassroots has helped to construct sanitary toilets, provide access to safe drinking water, and install rainwater harvesting systems and biogas plants. The toilets help to eliminate discharge of human waste into the catchment, while the biogas plants reduce dependence on firewood collected from forests. The project has also supported soil moisture conservation activities in small local streams, or *gadheras*, and has organized communities in eight villages to protect over 200,000 saplings of native species. More than 350 ha of village common land are now under protection, supported by 10 community-run nurseries. Over 500 traditional water harvesting pits (*khals*) have been constructed and rehabilitated. Micro-enterprises have become a major source of income for the communities, especially for women's self-help groups (SHGs) (Grassroots 2010).

The institutional framework for the project is provided by SHGs and Stream Level Committees which have joined forces to form a Basin Level Federation. The SHGs have also played a major role in project activities such as training farmers, introducing higher-value crops, and promoting off-farm microenterprises. SHG members also collect data and monitor indicators of biodiversity, hydrology and meteorology.

On a broader scale, the Basin Level Federation has provided a platform for dialogue with other stakeholders in the basin, including community-based organizations, government agencies, small enterprises and educational institutions. This has created space for different stakeholders to participate in and express their views on the ecological restoration of the basin.

Krishna-Cauvery Basin

In the 1990s, the state of Karnataka reorganized its Water Resources Department into three corporations, each responsible for managing a river basin. The purpose behind this move was to streamline river basin management in an integrated manner. Amongst other things, Karnataka hoped to mobilize private investment to supplement government funding and thus accelerate its irrigation programme.

Knowledge sharing in regional water events conducted by the Network of Asian River Basin Organization (NARBO) in 2010 and 2011 helped the state of Karnataka officials to learn about strengths and weaknesses of government and corporate river basin organisations (RBOs) in Asia, the conditions for RBOs to function effectively, how governments can determine an appropriate RBO model, keys for success on effective leadership in managing river basins, and improving water security and governance in river basins from lessons and

experience in Spain on institutional, legal and financial arrangements, and supporting technologies.

The Cauvery basin is managed by Cauvery Neeravari Nigam Limited, the Upper Krishna basin by Krishna Baghya Jal Nigam Limited, and the other major projects in Krishna Valley by Karnataka Neeravari Nigam Limited. The westward flowing rivers in the state are managed by the Water Resources Department Organization (Government of Karnataka 2010).

These corporations, or *nigams*, focus on participatory irrigation management, modernization of irrigation practices, and integrated agricultural and water management (Government of Karnataka 2010).

Andhra Pradesh groundwater systems

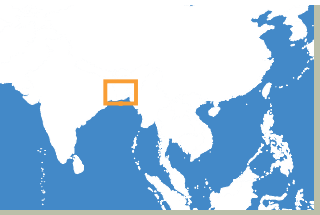
The state of Andhra Pradesh lies in the semi-arid region of South, or Peninsular, India. It has three major river basins — the Godavari, the Krishna and the Pennar — all of which are critical groundwater resources. About 85% of agricultural, 30% of urban and 50% of industrial water demand in the state are met through groundwater abstraction. An over-dependence on groundwater, coupled with a lack of recharging or sustainable management practices, has compromised water quality and quantity across large parts of Andhra Pradesh. The state's Groundwater Department has estimated that water resources in 9% of the state are over-exploited, while 6% is classified as critical and 15% as semi-critical.

The Andhra Pradesh Farmer-Managed Groundwater Systems Project (APFaMGS) was launched in 2003 across 638 villages in seven districts. These districts — Anantpur, Chittoor, Cuddapah, Kurnool, Mahabubnagar, Nalgonda and Prakasam — lie in the drought-prone region of the state where the climate varies from arid to semi-arid. The project, which advocates self-regulation to control groundwater depletion, is implemented by the Bharati Integrated Rural Development Society, in partnership with a number of NGOs and with support from the Food and Agriculture Organisation of the United Nations (FAO).

The project has been able to improve water use efficiency and groundwater management by helping farmers to monitor and manage groundwater resources, building local institutions to manage groundwater, augmenting groundwater reserves through artificial recharge, and promoting sustainable farming practices. It has empowered communities by demystifying groundwater management through appropriate training in crop-water budgeting, improved farming practices, hydro-geological concepts, and monitoring rainfall, water levels, irrigation efficiency and so on. Women farmers have played a particularly important role in managing and monitoring the project, as have purpose-built institutions such as Groundwater Management Committees and Hydrologic Unit Networks (Pangare *et al*. 2006).

The APFaMGS project has been recognized by the World Bank and other donor agencies as a sustainable groundwater management system with farmers as the focal point of management. Efforts are now being made to scale up the learning and innovations from the project to other basins and regions in India (APFaMGS project, 2010). ■

Groundwater resources are used extensively for irrigation in Andhra Pradesh



A wetland once leased to private parties now belongs to the community

BANGLADESH

BANGLADESH IS A lower riparian country sited on the floodplains of three great rivers: Ganges, Brahmaputra, and Meghna. Of these rivers' many tributaries and distributaries, 57, pass through Bangladesh, often bringing with them huge inflows of water from upstream catchments.

Though a recurring phenomenon, flooding varies in intensity. In a normal year, about 22% of Bangladesh is flooded during the wet season. Three-fifths of the country experiences a flood every twenty-five years or so (ADB 2003). High population density, poor resource management and frequent natural disasters have hindered social and economic development over the past two decades, especially because most Bangladeshis depend on water for their livelihoods, for example rice cultivation, captive fisheries, livestock breeding and jute processing. Many rural areas also depend on waterways for transport and communication.

Laws on managing water in Bangladesh overlap among different departments. A National Water Code is being drafted to rationalize this confused legal framework under the National Water Resources Council, Bangladesh's apex body for water policy and inter-agency coordination. The Water Resources Planning Organization of the Ministry of Water Resources provides the secretariat for the National Water Resources Council, and serves as a multi-disciplinary planning organization.

Tanguar Haor Basin

Lying in the district of Sunamganj, in northeast Bangladesh, the Tanguar Haor wetland covers 9,727 ha and forms part of the wetland and floodplain complex of the Surma and Kushiyara river basins.

These two rivers are the main tributaries of the Meghna river. About half of Tanguar Haor's area comprises waterbodies and almost a third is cropland. The wetland provides habitats for many different species of waterbirds and fish.

In 1999, faced with the threat of overexploitation of the Tanguar Haor ecosystem, especially of fish by private parties, the Government of Bangladesh declared it an Ecologically Critical Area. In 2000, Tanguar Haor was listed as the country's second Ramsar site in recognition of its international importance. With this listing, management of the wetland was transferred from the Ministry of Land to the Ministry of Environment and Forests. Subsequently IUCN Bangladesh, in 2006, on behalf of the Ministry of Environment and Forests, launched the Community-based Sustainable Management of Tanguar Hoar Project with funds from the Swiss Agency for Development and Cooperation (SDC). The goal of this project is to establish a functioning co-management regime to conserve, stabilize and sustainably use the resources of Tanguar Haor (Anon 2006). This regime is also intended to create opportunities for improving the livelihoods of local communities, and for contributing to the costs of management.

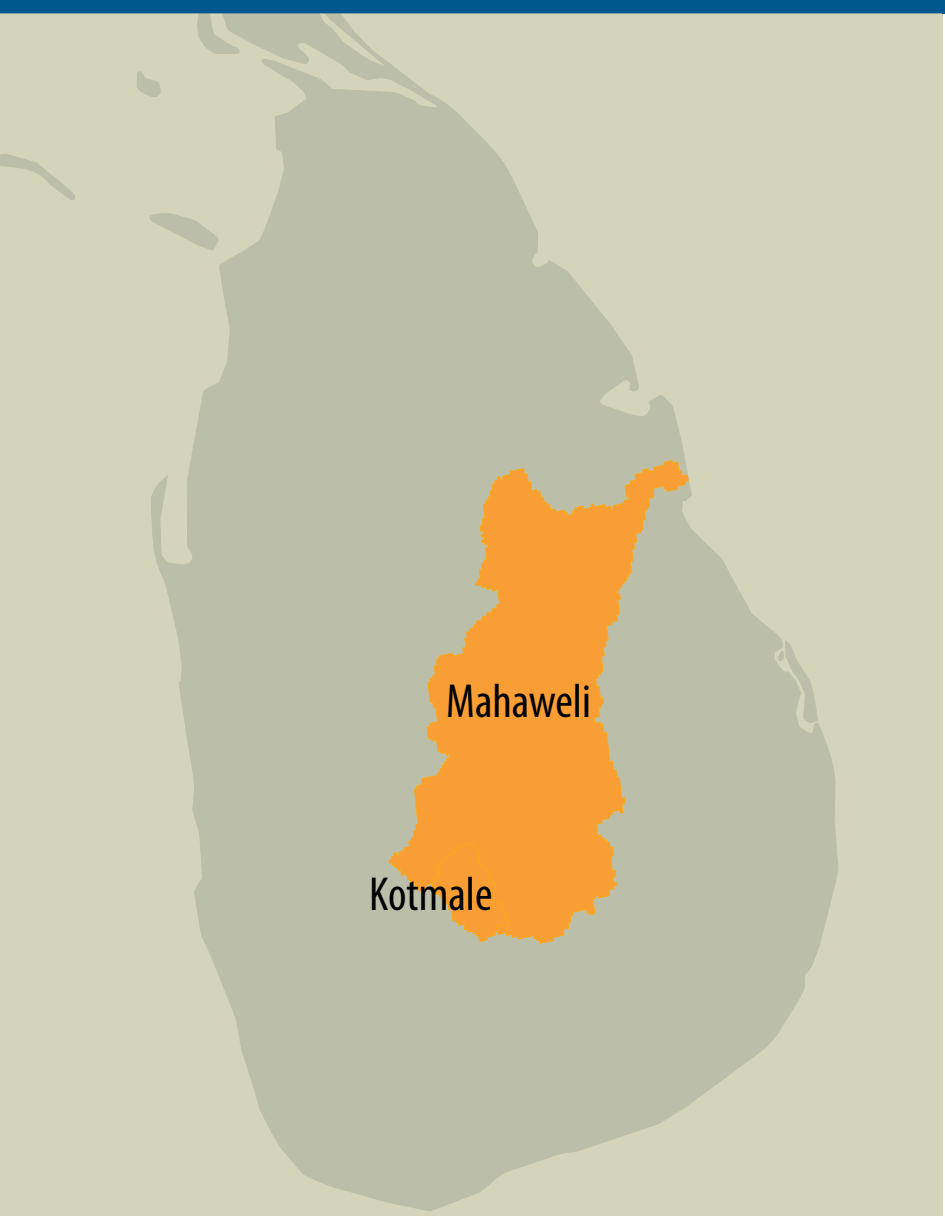
The project over a period of two years has enabled communities in Tanguar Haor to negotiate and implement measures for managing the wetland and improving their livelihoods. A successful co-management body has been set up to oversee the management system, with representatives from central and local government, and the local communities. Political and institutional support at the national, regional and local levels will help to ensure the scaling up and long-term sustainability of the co-management system at Tanguar Haor.

An achievement of the project has been the transfer of fishing rights from private parties to the local communities who are involved in the management of the wetland (Anon 2006). ■

Traditional fishing rights are protected by engaging the community in the management of the wetland

Consultation with stakeholders shapes and strengthens water management strategies in Sri Lanka

SRI LANKA



SRI LANKA IS divided into two climatic zones: a wet zone covering its southwest part and a dry zone covering the rest of the island. Although Sri Lanka has 103 rivers and adequate freshwater resources overall, the availability of water is affected by seasonal variations in rainfall, particularly in catchment areas, and an unequal spatial distribution of water resources. Increased competition among water users, a lack of compliance with pollution controls, weak land use policies, a lack of information for real time water planning, the absence of legal safeguards for water rights, and the degradation of rivers by mining and waste dumping, are the main challenges Sri Lanka faces in managing its water resources effectively (Senaratne & Elakanda 2004).

In 1996, Sri Lanka set up a multi-stakeholder Water Resources Council to lead the drafting of a National Water Policy and Water Act, based on recommendations from ADB and FAO (Bandaragoda 2006). In 2000, the policy and law were finalized after stakeholder consultations involving government agencies, NGOs and water users, and the policy was approved by the Cabinet of Ministers. River Basin Committees have also been formed to foster decentralized water management with participation of stakeholders and exchange of experience with other Asian countries through NARBO.

Mahaweli River Basin

The Mahaweli River Basin covers 10,000 km^2, one-sixth of Sri Lanka's land area. About 15% of the island's population lives in the basin, which extends across nine districts in five provinces. The river supplies water for irrigation and hydropower generation, as well as meeting the water

demands of urban and industrial areas in the basin (Senaratne & Elakanda 2004).

In 1979, the Sri Lankan government established the Mahaweli Authority of Sri Lanka (MASL) as the coordinating agency for the entire Mahaweli Basin. The responsibility for water resources management remained fragmented, however, lying with many different government agencies. This arrangement did not give MASL the authority it needed to manage the river basin in an integrated manner.

At the outset MASL also had a sectoral focus, in particular the construction of hydropower and irrigation infrastructure. Nature conservation was not part of its mandate. In 1996, a process of reform was initiated by the government of Sri Lanka to reduce MASL's role in construction, service provision and other line agency functions, and to transform it into a river basin management institution. It was also given the responsibility for managing adjacent river basins. These reforms shifted MASL's focus to planning and managing economic and resource development at a basin level, fully integrating environmental, social, economic and technical concerns (World Bank 2004).

The institutional reform of MASL included restructuring and retraining of staff, divesting of unprofitable business ventures, handing over MASL-built infrastructure to line agencies, and strengthening its natural resource management capabilities. The O&M of tertiary (i.e. field-level) irrigation infrastructure was transferred to farmer organizations, and service delivery functions to line agencies and administrative units in the basin. By mobilizing basin stakeholders and encouraging them to participate in the reform process, MASL successfully transformed itself from a project-implementing body into a river basin management institution. MASL's experience in the Mahaweli and adjacent basins has spurred the creation of other basin management organizations in Sri Lanka.

MASL is an active member organization of NARBO, and has held its Vice-Chairmanship since NARBO's establishment in 2004. MASL's pioneering application of NARBO's performance benchmarking service for RBOs has been a source of inspiration to improve its service in the Mahaweli river basin.

Kotmale River Basin

Kotmale River flows through the district of Nuwara Eliya in the south-central mountainous region of Sri Lanka. Although the river is just 70 km long, its basin is a valuable resource for hydropower generation, biodiversity and tourism. Most inhabitants of the basin work in tea plantations.

The Upper Kotmale Hydropower Project (UKHP) in the upper catchment of the Kotmale River covers 540 km^2 and can generate about 530 GWh of hydropower yearly. Among the five waterfalls along the river's course, only one, St Clair's, is affected by the project. The dam of the UKHP is sited on the edge of the small town of Talawakelle.

When it began, UKHP faced many challenges: not only technical ones, but also protests from NGOs, the media and local communities against the social and environmental impacts of the project. In response to these, multi-stakeholder public consultations were organized by UKHP with government agencies, civil society groups, organizations representing affected communities, professional associations, businesses, bilateral donors and multilateral development banks. These consultations eventually led to improvements in the design and management of the project (Nandalal 2007).

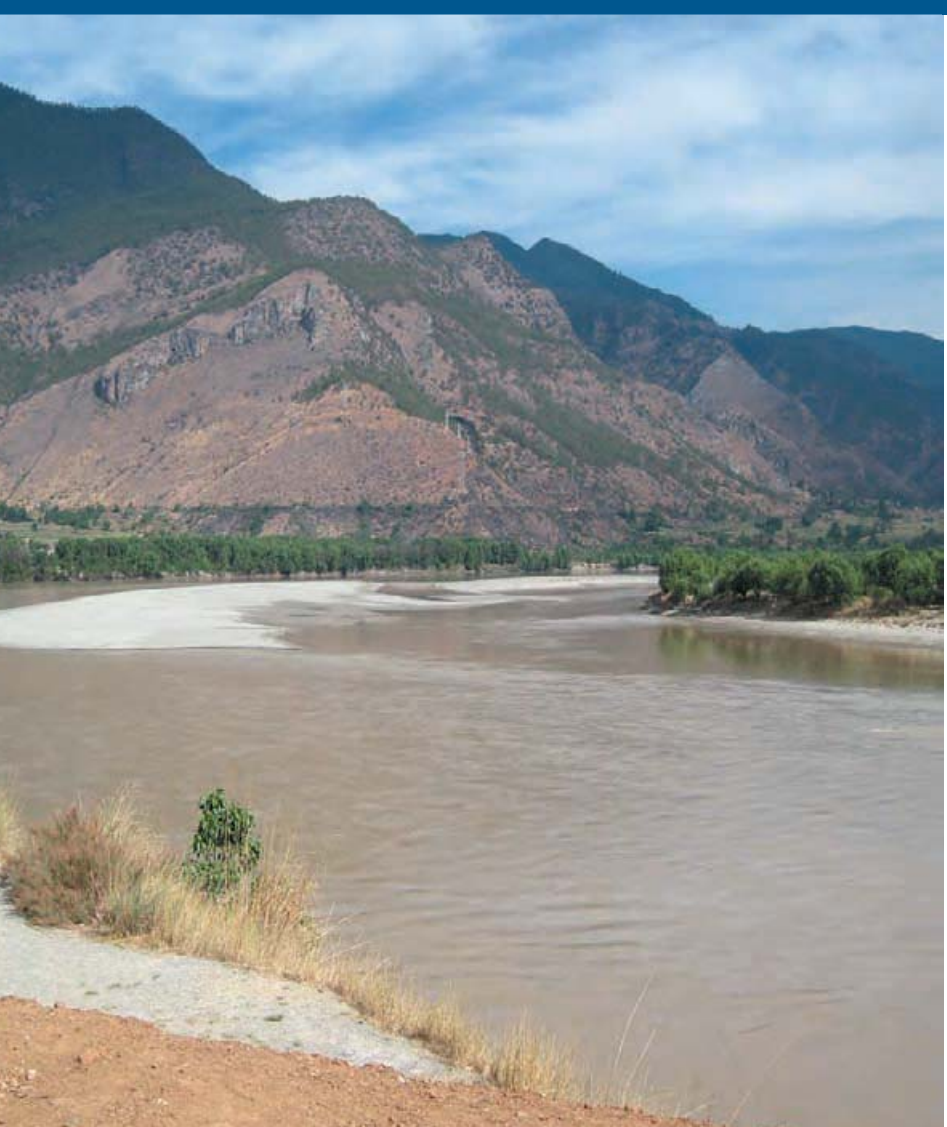
To address concerns about the loss of biodiversity and scenic beauty of the Kotmale basin, an Environmental Impact Assessment was carried out and the report made available publicly. The project plan was revised, reducing the scope of the project to just St Clair's waterfall, not all five waterfalls as originally planned. IUCN was invited to map the potential impacts on the river and suggest measures to mitigate and prevent any threats to biodiversity. A comprehensive watershed management plan was prepared by the Ceylon Electricity Board (CEB), the owner of the project, covering conservation-oriented agriculture, gully conservation, river bank protection with bamboo planting, improvement of poorly managed tea lands, and reforestation.

The Ceylon Electricity Board worked closely with community leaders to finalize and implement the Resettlement Action Plan

Another important issue calling for attention was resettlement of the 495 families displaced by the project. The CEB successfully worked with them to prepare and finalize a resettlement action plan, and helped to set up a housing committee which engaged in a continuous dialogue with CEB until the process of resettlement was completed. To prevent vested interests from interfering in this dialogue, CEB worked directly with the affected people to gain their support and cooperation. By maintaining close coordination and communication with community leaders, CEB was able to engage with local residents and complete the project successfully. ■

The PRC's extensive water management framework extends vertically and horizontally from the central government to its townships and villages

PEOPLE'S REPUBLIC OF CHINA



THE PEOPLE'S REPUBLIC OF China (PRC) has more than 50,000 rivers with a basin larger than 100 km^2, and some 1,500 basins larger than 1,000 km^2. Although the PRC is ranked sixth in the world in terms of its overall water resources, its per capita water availability is only one-third of the global average (Ministry of Water Resources 2008). Half of the PRC's demand for water is from the agricultural sector and the rest from industry and domestic consumers. Water shortages occur not only because of limited quantities, but also because of poor water management and pollution. Just over a fifth of the available surface water resources is unfit for agriculture, and only 38% of municipal wastewater is treated to minimum quality standards. In general, water shortages in the Yellow, Huai, and Hai Basins in northern PRC are due to limited quantities, and those in southern PRC are a result of pollution and mismanagement (Anon 2009).

The Ministry of Water Resources is the PRC's main water management agency. It is supported by a legal and institutional framework consisting of ministries, departments, bureaus and other agencies in a hierarchy arranged vertically and horizontally — from central government down through provincial, prefectural, municipal and county levels to townships and villages (Turner 2005). Several agencies operate at the sub-regional level, including provincial Water Resources Bureaus, as well as River Basin Commissions in each of the main basins. The Water Resources Bureaus implement water policy and regulations at a local level. The PRC's revised Water Law of 2002 defines river basin

management institutions and their functions, the legal status of river basin management organizations, and strengthens the administrative rights of river basin management organizations (Shen 2004).

Yellow River Basin

The Yellow River — the second-longest river in the PRC and one of the ten longest rivers in the world — plays an important role in the national economy. Flooding has been a threat in the basin since ancient times; newer threats stem from increasing water demand and pollution (Giordano *et al*. 2004). Managing the basin is the Yellow River Conservancy Commission (YRCC), established under the Ministry of Water Resources. The YRCC works closely with nine provinces and local governments, and serves as the Asia Pacific Water Forum's regional knowledge hub on decision-support systems for river basin management. YRCC has collaborated with ADB and other partners on several innovative projects.

One such project, supported by ADB, helped to mitigate future flood risk in the lower reaches of the river through a combination of structural and nonstructural investments. Groynes were constructed to protect vulnerable river banks, embankments were expanded to increase storage space for flood retardation, including around Dongping Lake, and entire flood-prone villages were protected by relocating them on elevated earth platforms. On the non-structural side, geographic information systems, flood forecasting and warning, and asset management were improved, and a flood command center was created. The legal framework was also strengthened, and the Yellow River Water Regulation Bylaw approved by the State Council in 2006 introduced principles for water use by the riparian provinces, demonstrating new directions for river basin management in PRC.

Apple harvest in the Yellow River Basin

Another successful project, supported by the World Bank, reduced sediment flow from the Loess Plateau into the river through regeneration of grass, tree and shrub cover on previously cultivated slopes, together with improved farming techniques and water harvesting to provide water storage for domestic and agricultural use. The introduction of sustainable farming practices doubled farmers' incomes, diversified employment, and contributed to revitalizing a degraded environment (World Bank 2008).

Jiamakou Irrigation Scheme helps to achieve higher water productivity in the Yellow River Basin

In 2005, during the second International Yellow River Forum, YRCC established the world's first river basin water partnership under the auspices of the Global Water Partnership (GWP). In 2010, YRCC received international recognition with the awarding of the prestigious Lee Kuan Yew Water Prize in Singapore for its healthy river policy and integrated approach to equitably allocate water among domestic, industrial and agricultural uses, thereby reversing a disastrous trend of over-exploitation of the river by riparian provinces which had resulted in zero flow in the downstream portion and estuary for years.

Chao Lake Basin

Cleaning up polluted freshwater lakes is one of the greatest challenges in PRC's water management. Since the mid 1990s, the government's efforts in the Tai, Dianchi, and Chao Lakes have been hampered by the lack of an effective cross-jurisdictional management system for clean-up. Chao Lake, PRC's fifth largest, struggled to overcome one of the most serious eutrophication problems in the country caused by decades of pollution spurred by economic growth pressures. Drawing on these lessons, the State Council decided to create an integrated management authority for Chao Lake in Anhui Province, the first such body in PRC. The mandate of the authority includes land use planning, water quality and quantity issues, fisheries, navigation, and tourism. The authority can build on the results of earlier projects to improve watershed management and tackle waste management in townships and villages, as well as agricultural non-point source pollution and industrial waste management. ADB has supported several projects across the Chao Lake basin since 1996.

Songhua River Basin

The Songhua River Basin is the third largest river basin in the PRC. Almost the entire northeast of the country lies within this basin. The Songhua is one of PRC's four most polluted rivers, suffering until recently from untreated urban wastewater, industrial wastewater and agricultural non-point sources. A benzene spill in the basin that gained international attention in 2005 highlighted the need for further basin-wide technical and institutional analysis, supported by a concerted investment programme to clean up the river. The programme has helped to reduce water pollution, protect water resources, address water shortages through recycling effluent, and control agricultural non-point source pollution and effectively manage solid waste. Working in partnership with ADB since 2001 on basin analysis, institutions, and investments, the provincial and central governments have achieved steady improvements in pollution control and livability of the basin for its residents. In 2011, PRC and the Russian Federation have agreed to work together in the further clean-up of the Songhua river.

The Onggi River Movement has demonstrated the need for active involvement of the people in restoring the basin ecosystem

Climate Change, and National Action Plan for Combating Desertification. Numerous laws also deal with water management issues. In 2004, the country declared a "National Year of Water" and passed a new Water Act calling for the introduction of IWRM practices. A project called Model Region Mongolia is being initiated under the Integrated Water Resources Management for Central Asia Project funded by the Federal Ministry of Education and Research of Germany that will introduce basin management on a large scale (Anon 2010).

Mongolia also has a major people's movement for river restoration. Known as the United Movement of Mongolian Rivers and Lakes (UMMRL), it federates seven separate civil movements: Onggi River Movement, Toson Zaamar Movements, Salkhin Sandag Association, Angir Nuden Munduuhei, Khuder River Movement, Calling of Mountains and Rivers Movement, and Nature Protection — Local Development.

UMMRL covers 21 *soums* (sub-divisions) in nine of Mongolia's 21 provinces. Its mission is to protect and rehabilitate watersheds. In 2009, after intense lobbying and campaigning, the movement successfully forced the government to pass a law prohibiting mining operations in the headwaters of rivers, and instituting protection zones for reservoirs and forested areas.

Onggi River Basin

The Onggi River originally extended 437 km, linking the Khangai mountains in central Mongolia to the Gobi Desert, where it flowed into Ulaan Lake. It is now only 100 km long,

Revival of the ecosystem resulted in economic gains for the local people

Yangtze and Tarim River Basins

Valuable lessons in river basin management have also been learned from projects in the Yangtze (Changjiang) Basin, Asia's longest river and the third longest in the world, and in the Tarim Basin, the largest internal river basin in the country draining into Taklamakan, the world's second largest desert. The Yangtze Basin provides 36.5% of the total amount of water available nationally, and 60% of the country's potential capacity for hydropower. The basin also supports two-thirds of the PRC's 3,980 plant species and more than 370 fish species, nine of which are rare or critically endangered (GWP 2008). Working in partnership with the World Wide Fund for Nature (WWF), the Changjiang Water Resources Commission has launched several projects to demonstrate the benefits of wetland restoration for biodiversity and the sustainable generation of income for local communities (Huitema 2008).

In 1999, the Tarim Basin Water Resources Commission introduced a quota on water diversions for irrigation that led to large cuts in the water allocated to agriculture. Initial resistance from farmers was eventually resolved through negotiations. The quota system imposes limits on monthly diversions and compliance is closely monitored. Basin-wide management and monitoring have led to an increase in lake area, rising groundwater levels, improved vegetation cover, and greater agricultural intensification and production. Water flows have been restored in the lower reaches of the Tarim River, and the impact of wind and sand storms mitigated by the increase in forest and grassland cover. By applying geo-membranes to line irrigation canals, water was saved for reallocation to environmental, municipal and industrial uses. Accompanying institutional reforms have included the formation of farmers' water user associations, and the introduction of volume-based water tariffs (Lyle & Mu 2003).

Miyun Watershed

The PRC's capital, Beijing, receives most of its water from outer catchments. The Miyun reservoir is an important source of drinking water for the city, and its preservation is vital to Beijing's residents and businesses (Peisert *et al*. 2005). In partnership with the German government and IUCN, the PRC's State Forest Administration, Beijing Forestry Society and Beijing Parks and Forest Department are carrying out projects in Miyun to improve livelihoods, introduce sustainable forest management, protect critical watershed areas and advocate for changes in policy. An IUCN-supported project has been successful in increasing forest cover in the Huayuan sub-watershed, specifically by enlarging the area under forest and reducing the area under grass and agriculture. Discharges of solid waste and wastewater into the sub-watershed have also been brought under control (Anon 2010).

Drawing lessons from these projects, Miyun watershed has become an example in PRC for adopting eco-compensation in support of cross-jurisdictional watershed management. Downstream beneficiaries (water users and local governments, including Beijing municipality) are paying compensation to upstream ecosystem service providers (local governments and communities in counties of Hebei Province where per capita incomes are half of those in Beijing) for development restrictions to reduce watershed impacts. Almost $60 million is transferred each year to fund land conversion from irrigated rice fields to rain-fed farming, water pollution control, water resource protection, afforestation, and forest management. Of this amount, 60% is distributed to forest owners as a basic payment, and 40% is channeled as incentive payments for forest management and landscape restoration (ADB 2011). ■

Farmers have been major beneficiaries of the river basin management efforts in the PRC

The United Movement of Mongolian Rivers and Lakes successfully lobbied for a ban on mining in the headwaters of rivers and the protection of reservoirs and forested areas

MONGOLIA

MONGOLIA IS HOME to the world's largest intact temperate grassland ecosystem. Only 1% of Mongolia is arable, and about 60% of its population depends either directly or indirectly on raising livestock for its livelihood. Mongolia has about 4,000 rivers, some flowing north towards the Arctic Ocean, some east towards the Pacific, and some south into the Gobi Desert. Several of the world's longest rivers, including the Yenisei, Lena and Amur, rise in the hills and mountains of Mongolia. Two-thirds of Mongolia's river run-off drains into Russian Federation and the PRC, and the rest flows into the lakes of the Gobi Desert. Mongolia's water resources are unevenly distributed across the country, and river flows are variable, with major seasonal and regional fluctuations (Davaa 2008).

Mongolia's water resources face a growing number of threats, including rising demand from industry, agriculture and urbanization. The main threat, however, is from mining, one of the country's largest and fastest-growing industries, which accounts for more than 8.6% of GDP and 56% of export earnings. Mongolia's mineral resources include gold, platinum, uranium, copper, zinc, oil and natural gas. Over the years, mining has affected many river systems through diversion, pollution and the reduction of environmental flows. A study by the country's Ministry of Nature and Environment in 2002 found that 29 rivers across eight provinces were in danger of drying up mainly due to mining (Ministry of Nature and Environment 2002).

Mongolia derives its water policies primarily from its National Water Programme, National Programme on Reduction of Natural Disasters, National Action Plan on

less than a quarter of its natural length, and Ulaan Lake dried up in 1995. About 3,000 people live in the river basin, many of whom are nomadic herders. In 2001, these pastoral communities created one of Mongolia's first local environmental movements, the Onggi River Movement (ORM). In 2002, ORM's leadership successfully lobbied the Ministry of Nature and Environment to conduct research on the causes of water depletion in the Onggi River. The study found that heavy mining had diverted the river from its natural course, silted streambeds, lowered water tables and polluted entire watersheds with mercury, cyanide and other toxic chemicals. The resulting damage to ecosystems, and the economic, health and social costs to local communities, were enormous.

ORM requested the study report from the Ministry, and for the Onggi basin to be protected and a monitoring plan formulated. The official response to these requests was slow, with confidentiality and other issues cited as reasons for not releasing the report. In April 2003, the movement submitted a petition requesting the Prime Minister to halt mining in and around the source and outflow of the Onggi River, to ensure that the lands abandoned after gold extraction were properly rehabilitated, and to include the Onggi River and Ulaan Lake basins in the State Special Protected Area system (IUCN, ADB 2006). The petition was signed by 1,200 people, mostly residents of the basin.

To raise awareness and support among officials and citizens, in 2004, ORM organized an "Ecology Protest March" along the entire natural length of the Onggi River. Over 2,000 people joined the march. During the event, Onggi leaders addressed 12 public rallies, including a protest rally at a gold mine. All of these received extensive media coverage. Court cases filed by ORM against the companies involved also helped to raise the national profile of this and other environmental concerns. As a result of this slew of protests and campaigns, operations were halted at three gold mines accused of polluting the river.

Today ORM has more than 900 active members across the basin. A governing council with nine members, a monitoring council and a board in each of the eight *soum* it covers have been established. The movement has become celebrated in Mongolia and internationally, with its leader, Tsetsegee Munkhbayar, receiving the prestigious Goldman Environmental Prize in 2007 and being recognized as a National Geographic Emerging Explorer in 2008. ORM was one of the first such movements in Mongolia, and its achievements contributed to the establishment of the UMMRL (The Rivers Movement 2010).

Onon River Basin

The Onon River originates on the northeast slope of the Khentii Mountain range. The Onon River and its tributaries directly drain into the Amur through the Shilka River, all of which are ultimately destined for the Pacific Ocean. The total length of the Onon River is 808 km running through Mongolia and the Russian Federation, of

Onon River Basin is rich in biodiversity and the Onon-Balj National Park was established in 2000 to conserve these resources

which 575 km flow through Mongolian territory. Onon River Basin embraces an important catchment area forming the headwaters of the Amur/Heilong River — the longest undammed river in the Eastern Hemisphere. In an effort to conserve the area of outstanding beauty of nature with rich forests and water resources, the Onon-Balj National Park, which covers 415,752 ha, was established in 2000. The biodiversity of the national park is rich and unique as it is located in the transitional zone — from Siberian taiga to Duarian and Manchurian dry steppe (WWF-Mongolia Programme Office 2010).

As highlighted in the Mongolian Country Environmental Analysis (ADB 2004), a strong linkage between poverty and environmental degradation was witnessed in Mongolia. The gradually progressing environmental degradation in the Onon River basin is not an exception. To respond to the interlinked issues in the area, ADB financed a grant project "Poverty Reduction through Community-based Natural Resource Management" through the Japan Fund for Poverty Reduction during 2008-2012. Since late 2008, the project has been executed by the Ministry of Nature, Environment and Tourism and implemented by WWF-Mongolia Programme Office. The project, covering seven *soum* of Khentii and Dornod provinces within the Onon River Basin, helps to promote sustainable natural resource management and to contribute to poverty reduction in the basin. Specifically, the project has provided capacity building and resources to foster the development of effective environmentally-focused community-based organizations, strengthened local government capacity and resources to effectively implement natural resources management policies, developed new sources of livelihoods for poor households in protected areas and buffer zones, and enhanced environmental conservation planning and management in the Onon River watershed through investments in technical research and strategy development.

As outcomes of the project, 108 environmental community-based organizations have so far been formed and/or capacitated; buffer zone councils have been established in each of the seven project *soum*, and Onon River Basin Council, an overarching body of the buffer zone councils, has been set up. The project also resulted in an Onon River Basin management plan, a Onon-Balj National Park management plan, and buffer zone management plans for the seven project *soum*. Small grants will be shortly provided for local micro, small and medium enterprise development to improve the livelihood of the community people, which is expected to underpin the implementation of the environmental management plans along Onon River Basin.■

Community-based organisations are empowered to manage buffer zones more sustainably through capacity building exercises

Japan's water policies have been revised and adapted over the past 60 years in response to changing needs

JAPAN

JAPAN'S FAST-FLOWING mountain rivers are vulnerable to erosion and sedimentation. Floods are common and can cause considerable damage, as about half of the country's population and three-quarters of its industries, housing and other infrastructure are concentrated in low-lying areas. As Japan has grown, urban areas have encroached upon floodplains. In the past decade, more than 90% of Japan's municipalities have experienced floods and sediment-related disasters (Ministry of Land, Infrastructure, Transport and Tourism 2008).

Japan's water policy was first formulated after the end of the Second World War, when increasing food production was a national priority. The policy emphasized land and water management, and energy production. Subsequent policies have been revised and reformulated in response to contemporary needs and issues, such as river basin planning in the 1960s and 1970s, and environmental protection in the 1990s. Similarly, the country's River Law has been amended as and when necessary, most recently in 1997. This last amendment stipulated that new river improvement plans must integrate flood control, water utilization and environmental concerns (Onomi 2010).

Rivers are categorized into Class A and Class B depending on their quality and environmental importance. At regional and local levels, water resources are managed by the Ministry of Land, Infrastructure, Transport and Tourism, and by the governors of prefectures, where the Japan Water Agency has responsibility for implementing basin management plans and developing water resources such as dams, barrages and canals (Ministry of Land, Infrastructure, Transport and Tourism 2008).

Yoshino River Basin

The Yoshino River flows through Shikoku Island in southeastern Japan. The Yoshino River Basin Management Plan of 1966 was one of the first such efforts in Asia and the Pacific region. It was formulated to mitigate the impacts of floods and earthquakes, and in response to the high demand for water and power for irrigation and urbanization (Ministry of Construction, Shikokou 2010).

The coordination of the Yoshino River Basin Management Plan of 1966 began in 1945 and took 20 years to complete. Consultations were held with local stakeholders, including communities from four areas inside and outside the basin: riparian residents in Tokushima on the east of Shikoku island, upstream residents of Kochi on its southern coast, and transboundary water users in Ehime and Kagawa on its northern side. The plan initially focused on dam construction, water allocation, and rehabilitation of communities, but was rejected by stakeholders as it did not meet the specific needs of the different groups. The plan also did not adequately address flood control measures, river flows during the summer months, and water allocation.

After several rounds of discussions with stakeholders, authorities realized that a more coordinated and detailed plan was needed to address local concerns. There was a need for a common water budget, and for data from different sectors to be collated and combined into a wider plan. This led to the development of a comprehensive regional development plan for Shikoku, covering infrastructure and natural resources development, including water. A working group was formed with members from the prefectures, government and the island's electricity provider. The group prepared a new basin development plan reallocating water to the satisfaction of all stakeholders. A drought conciliation mechanism was later added to the plan in 1975, and a mechanism to ensure environmental flows in 2001 (Onomi 2010).

The Tama River Basin was restored as a result of awareness raising campaigns by citizens which led the government to formulate the Environmental Management Plan

Tama River Basin

The Tama River Basin lies to the southwest of Tokyo and plays an important role in the socioeconomic development of the capital region. The Tama is a Class A river, and its basin includes 23 cities, two towns and three villages with a combined population of about 4.25 million people. Intensive use of the river's water in public utilities, agriculture, industry and power generation has led to conflicting demands and stresses on the resource. Urbanization has also led to increased flooding and declining water quality (Kanto Regional Development Bureau 2002a).

Campaigning by citizens led the regional government to formulate an environmental management plan for the basin in 1980. This had two aspects: a space management plan (space for nature and education) and a surface water management plan (including for navigation, waterside activities and waterside nature) (GWP 2010). In 1998, the Tama River Citizens Forum was established to work with the regional government to formulate the Tama River Improvement Plan. The plan was finalized after an intense participatory process lasting two years. During this, local residents, civic groups, municipal employees, academics and river

The Nissan Stadium, the largest sports stadium in Japan, was built on an elevated platform

administrators took part in a range of activities to encourage discussion and build consensus, including meetings, seminars and nature walks (NARBO 2009). Both scientific and local knowledge were taken into account in preparing the plan, and the entire process was kept as open and as transparent as possible (Kanto Regional Development Bureau 2002b). Today, the Tama riverside provides a cultural and social space for artists and residents, and is also a major tourist attraction.

Urban citizens are more informed of the need to restore Japan's river basins

Tsurumi River Basin

The Tsurumi River flows from north of Machida City, Tokyo, through the Tama Hills, and down into Tokyo Bay. Its basin includes important cities such as Kawasaki and Yokohama, as well as part of the Keihin Industrial Zone. The basin lies in the heavily urbanized Tokyo Metropolitan Area, and supports a population of 1.88 million (Anon 2005). Flooding and urbanization are the two main challenges in the basin. The downstream section of the Tsurumi River is prone to flooding, and rapid urbanization has not only increased runoff but also raised land prices, making conventional flood control measures costly and impractical (NARBO 2009).

Under the Tsurumi River Basin Improvement Plan, drafted in 1981 and revised in 1989, a comprehensive range of river improvement, basin improvement and flood damage reduction measures has been taken to mitigate flooding. Chief among these is the establishment of a multipurpose retarding basin at the junction of the Tsurumi and Toriyama Rivers in Yokohama. The development of this basin took almost two decades; high land prices impeded the land acquisition process for the project. After much deliberation between the land owners, developers and the government, it was agreed that the retarding basin would also serve as a recreational space for local residents, to justify its development costs. Today, the retarding basin, which spans 84 ha and has the capacity to hold almost 4 million m^3 of floodwaters, is home to a natural park and the Nissan Stadium, the largest sports arena in Japan.

The Tsurumi experience has shown that moving from conceptualizing to implementing a comprehensive basin management plan can take many years, if all technical, environmental, legal and social aspects are to be taken into account. Local authorities have to be motivated and incentives provided for them to support the plan. An integrated database is also critical to the success of a plan. Yet, despite such measures, trade-offs are inevitable and not all stakeholders can be completely satisfied. To ensure the best possible outcome, citizens must work with both government and the private sector to decide how limited resources should be allocated. ■

Upgrading the Environment Administration to ministry status has ensured legal and administrative support for tackling water pollution

REPUBLIC OF KOREA

THE NATIONAL TERRITORY of the Republic of Korea was divided in 1991 into four large, 11 medium-sized administrative zones and one special zone, centred on the basins of the country's four largest rivers: Han, Nakdong, Geum and Yeongsan. Industrial activity and urbanization in these basins have contributed to high levels of water pollution. In 1990, the Korean Government upgraded its environment administration to the status of a ministry. This move strengthened the legal and administrative framework for tackling environmental pollution. Other measures taken to secure the country's water resources have included the Comprehensive Measures for Clean Water Supply, launched in 1993 to promote integrated water management, the Long Term Comprehensive Water Resources Plan to promote efficient water allocation, and the Comprehensive Water Saving Plans to address future water scarcity (Ministry of Environment 2010).

Nakdong River Basin

The Nakdong River is the main source of drinking water of the city of Busan. It became heavily polluted in the 1970s and early 1980s. High pollution loads flowed from the upstream city of Taegu, the third largest city in the country and the site of a large textile industry. Concerns raised by Busan residents through the Nakdong River Pollution Prevention Committee led authorities to install tertiary treatment processes in their water treatment plants. These raised costs, and led to an increase in water user charges. Moreover, research revealed that the cost of water treatment was higher than that of protecting upstream water sources. This finding prompted Busan to invest in protecting its sources, using a river basin management fund capitalized with part of its income from water user fees.

At the same time, the Korean Government realized that pollution was affecting other downstream cities besides Busan, including the capital Seoul in the Han River Basin. The government also realized the enormity of the economic and social costs imposed by pollution. Taking its cue from Busan, the government decided to apply the same principle of charging water users for protection costs in every major river basin in the country.

Under this scheme, end users pay for the cost of conserving or protecting their water supply through a water user fee. Busan's initiative has evolved into a system whereby water revenues collected from users are used to manage upstream water resources, reducing the investments and operational costs of water treatment facilities. Korea's river basin management funds are also used to finance wastewater management infrastructure in upstream areas (Ministry of Environment 2004). ■

The city of Busan in the Nakdong River Basin gets clean drinking water by protecting upstream water sources paid for by a River Basin Management Fund

Thailand's inclusive approach ensures effective and innovative basin management through stakeholder participation

THAILAND

RAPID ECONOMIC GROWTH in Thailand in the past three decades has greatly increased the demand for water from different sectors, and the corresponding need to manage water wisely. The gap between demand and availability of water is increasing, however, and the resulting shortfalls are often a cause of conflict between users, especially in the dry season.

Thailand has 25 major river basins and 254 sub-basins. It receives about 1,700 mm of rainfall each year, with some regional variations. Three-quarters of this goes to evaporation, evapotranspiration and infiltration, and the rest runs off in rivers and streams (Nitivattananon 2005).

The overall responsibility for Thailand's freshwater resources rests with the Ministry of Natural Resources and Environment. Its Department of Water Resources was formed by merging five water-related agencies to raise awareness and promote integrated management of water resources.

As part of its efforts to engage water stakeholders, the Department of Water Resources in 2004 commissioned the drafting of a national Water Resources Law aimed at updating and consolidating Thailand's fragmented legal framework for water management. Drafting proceeded through public hearings, and the feedback received was used to finalize the draft law, which is awaiting parliamentary approval.

The IWRM approach was introduced in Thailand in 1999 through a national dialogue process, winning support and acceptance from a wide range of water stakeholders. The National Water Vision and the National Water Resources

Policy of 2000 were the results of this process. To implement the policy, RBOs have been established in each of the country's major river basins (Anukularmphai 2008).

Yom River Basin

The Yom River is the least developed of the major tributaries of the Chao Phraya River, both in terms of management and in terms of its water infrastructure. A 20-year-old proposal from the Royal Irrigation Department to build the Kaeng Sua Ten Dam on the river gave rise to disputes between water users and communities living in the basin. Although local advocacy groups opposed the dam because of concerns over its environmental impact, downstream communities were supportive as it promised to reduce flooding in their area.

In 2008, the Ministry of Natural Resources and Environment of Thailand, with support from ADB, launched a pilot project to help the Yom River Basin Committee, local authorities, civil society groups and communities integrate IWRM principles into basin management. Stakeholder participation was promoted through a consultative process involving basin and sub-basin committees, aimed at reducing conflict between water users. The project put a strong emphasis on reorienting management towards a collaborative approach to solving problems. An adaptive basin management plan, with regular stakeholder reviews, helped to foster a collective outlook, resulting in closer cooperation between civil society stakeholders and officials from line agencies (Pangare *et al*. 2006).

The project was managed by the Yom River Basin Working Group located at Phrae, comprising representatives from key government agencies, stakeholders from all four provinces in the basin, and local universities. To promote ownership and encourage stakeholders to engage more actively in the process, a leading Buddhist monk was appointed chair of the Working Group. This brought previously opposed stakeholders together in a dialogue under the leadership of someone they respected and revered.

The project focused on raising awareness about IWRM within the Working Group, as well as among other relevant stakeholders. It was successful in getting government officials, civil society groups and local communities to work together to manage the basin, and in fostering a dialogue between the sub-districts in the basin. Another important achievement of the project was the signing of a memorandum of understanding between upstream and downstream sub-districts to monitor and control water quality.

In 2009, after a pilot and demonstration activity (PDA), a Yom Basin Data Collection and Information Centre was

The Bang Pakong River Basin Committee was successful in resolving water allocation issues

The water lily *Thainium crinium,* an economic resource for the local people is now recognized by the Government of Thailand as a rare and endangered flora

set up under the project to receive and store information from sub-districts in a format that stakeholders can readily understand and use. Using this system, priority issues can be identified for joint projects between and among sub-districts, districts and provinces. The system has further helped to establish a flood warning system. Youngsters have also been involved through a programme encouraging school children to participate in monitoring river water quality (Thailand Water Resources Association 2008).

Bang Pakong River Basin

Located in eastern Thailand, the Bang Pakong River Basin supports mainly land-based livelihoods such as agroforestry, agriculture, fisheries and livestock raising, though it also has some medium-scale industrial development. Although several water infrastructure projects have been undertaken in the basin to meet increasing demands for water, they have caused conflicts among stakeholders and worsened water pollution, flooding, river bank erosion and soil degradation.

To reduce these conflicts and unite stakeholders the Bang Pakong River Basin Committee (BPRBC) was established in 2001. Between 2004 and 2006, the ADB-financed Bang Pakong Dialogue Initiative supported the

Farmers harvesting rice in eastern Thailand

BPRBC in building its networks, improving management procedures and engaging stakeholders in decision-making on water allocation. The initiative also focused on building the capacity of the BPRBC Secretariat through a series of training events and study visits to other river basin committees. A knowledge-sharing mechanism for basin stakeholders was set up to support community-based research and dialogue.

As a part of its knowledge-sharing agenda, the initiative created an information generation and management system with inputs from local stakeholders. This exercise contributed to the introduction of the Water Evaluation and Assessment Programme decision support tool, used to guide water allocation in the basin. Training in the Programme has enhanced skills in data generation and analysis among basin managers, who now have the capacity to plan water allocation and share relevant information with stakeholders across the basin (Kasetsart University 2006).

Na Kha River Basin

The Na Kha River in southern Thailand is home to the endemic water lily *Thainium crinium.* The lily is a source of income for local people, who collect and sell its bulbs to markets in Europe and Singapore. Unfortunately, dredging of the river and uncontrolled collecting of the lily have pushed it close to extinction. Faced with the impending loss of the lily, the local community organized themselves into an action group aiming to conserve the lily's remaining populations. Out of this effort came forth the Pleon Prai Sri Na Kha Group in 1999. Bringing together 110 households from six villages in Na Kha sub-district, the group is engaged in raising awareness and other activities to protect the water lily and its habitat.

Another group, the Na Kha Conservation Group, was formed in 2005 through the initiative of villagers from Ban Fai Tha, also in Na Kha sub-district. With support from IUCN, this group manages five different locations along the Na Kha River, including small canals, where it focuses on monitoring the quality of the river ecosystem. In collaboration with Pleon Prai Sri Na Kha Group, the group is preparing a management plan for the river which will include activities such as monitoring water quality and erosion, setting up nurseries, collecting water lilies, training young people. and promoting ecotourism activities.

Thanks to constant lobbying by these groups and support from international organizations such as IUCN, the government has now recognized the water lily as one of Thailand's ten most endangered plant and animal species, and in need of special protection and conservation (IUCN 2010). ■

Three countries are engaging in national and cross-border dialogue to improve the management of a transboundary river basin

3S RIVER BASIN

THE SESAN, SRE POK AND SEKONG (3S) rivers form a transboundary basin straddling roughly equal proportions of Cambodia, Lao PDR and Viet Nam. The three rivers are fed by water from the Central Highlands of Viet Nam, from where the Sekong flows southwest through Lao PDR, and the Sesan and Srepok flow west through Cambodia. They merge before joining the Mekong River in Stung Treng province in Cambodia. Their basin contributes about 17% of the annual discharge of the Mekong River.

Although the 3S basin's water resources have long been used for agriculture, forestry, hydropower, fisheries, industry, domestic supply and, more recently, ecotourism, it has not seen sustained economic growth. A lack of multi-sectoral, basin-wide planning and stakeholder participation has contributed to a developmental approach aimed at generating rapid economic benefits without adequate consideration of upstream management or downstream impacts.

The management of water resources in the 3S basin is fragmented both vertically between national and sub-national levels in Lao PDR, Cambodia and Viet Nam, and horizontally among different sectors. There is little of the systematic cross-border coordination that would enable countries to manage the basin in an integrated manner. As a result, water development in the basin is shaped largely by national approaches to managing water resources. What is needed, therefore, is a coordinated governance structure that can manage the basin for sustained socio-economic development (ADB 2006).

Since the three rivers are a tributary system of the Mekong River, and the National Mekong Committees in the three basin countries are each involved in the formulation of national water policy and strategy, the

The 3S basin is very rich in inland fisheries

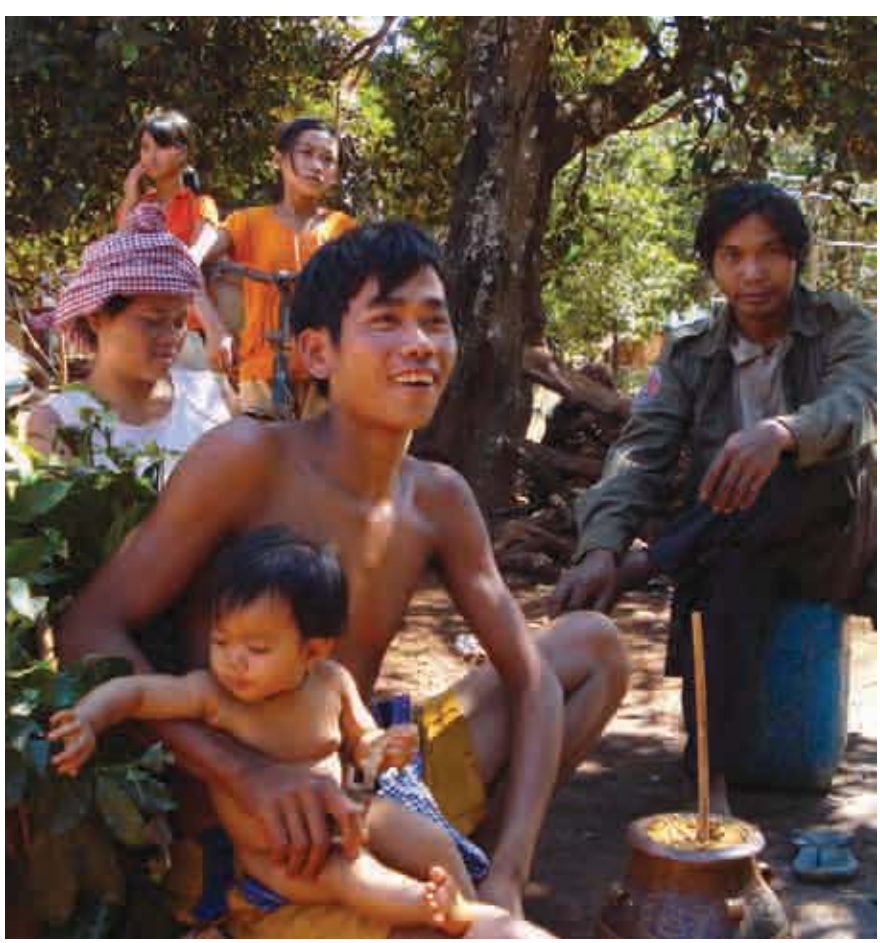
Mekong River Commission can play an important role in coordinating cross-border management of the basin water resources.

To improve management of the 3S basin, Lao PDR, Cambodia and Viet Nam have agreed to adopt an IWRM approach. Between 2007 and 2009, ADB provided financial and technical support for implementing IWRM in the basin, following a work plan developed through regular coordination meetings and workshops involving the National Mekong Committees and international experts. The Sre Pok sub-basin established an RBO in 2006 through a bottom-up process.

The Mekong Water Resources Assistance Strategy (2006) proposed strategic collaboration in the 3S, and identified four broad areas of intervention:

1. Water governance: institutions for river basin water resources management and planning frameworks.
2. Water for social development: water supply for rural communities, small towns and urban areas; and strengthening the small-scale productive use of water.
3. Water for economic development: agricultural development and product processing; hydropower development; and fisheries and aquaculture.
4. Water resources and development: watershed protection and management; wastewater management; and flood protection and control.

Three main activities are proposed as the foundation of effective IWRM planning under this Strategy: strengthening institutional arrangements, raising awareness about IWRM, and developing procedures for stakeholder participation at all levels. New institutional arrangements are currently being put into place to implement these at the provincial and national levels, and



to encourage transboundary collaboration for developing joint projects and programmes. Regular national and regional consultative workshops and other meetings are being held to coordinate this process (ADB 2010). ■

Policy and institutional changes in Viet Nam are responding to the need to modernize river basin management

SOCIALIST REPUBLIC OF VIET NAM

VIET NAM HAS 13 large river systems, each covering over 10,000 km^2. Two-thirds of its population live within the three largest river basins — the Red Thai Binh, Mekong Delta and Dong Nai — which also contribute 70% of the country's GDP. About 40% of the country's energy needs are met by hydropower, half of which is generated in the Red Thai and Dong Nai basins (ADB 2009). Although on average Viet Nam has abundant water, pollution and over-exploitation for irrigation and hydropower generation are decreasing the quantity of water available for consumption and productive use. A rapidly increasing population is also putting pressure on water resources and the environment in these basins (Hanh *et al*. 2009).

Water resources are national assets and are managed under State authority. Until recently, Viet Nam's government focused its water management efforts on preventing disasters, since the country is prone to typhoons and torrential rains in combination with strong winds, floods, landslides and mud flows. In 1998, Viet Nam formulated its first Law on Water Resources, and in 2002 it set up the Office of the National Water Resources Council and began creating RBOs for water resource planning in large rivers (Trang 2005). Later, the Ministry of Natural Resources and Environment was established with a view to modernizing basin management.

Red River Basin

The Red River Basin is a transboundary river basin spanning parts of the PRC, Lao PDR and Viet Nam. In Viet Nam, the basin covers 26 provinces including the capital city, Ha Noi, with a combined population of about

28 million people. Almost 40% of the water in the basin originates outside Viet Nam, making its water resources vulnerable in terms of quality and quantity to upstream management practices. The basin is widely known for the richness of its natural resources, yet annual water availability is low in comparison with other parts of Viet Nam.

In view of the economic importance of the Red River Basin, the Vietnamese Government established the Hong (Red) River Committee to manage the basin in the early 1960s. With the passing of the Law on Water Resources in 1998, the government introduced an integrated river basin management approach and, with support from ADB, formed the Red Thai Binh River Basin Planning Management Board (RRBO). The RRBO was expected to tackle issues of basin planning, dam management, and flood control. In practice, however, the size and complexity of this huge basin made it difficult to address these issues in an integrated fashion. Institutional conflict also hindered management, as the RRBO was set up under the Ministry of Agriculture and Rural Development with limited functions and power as various other government departments had greater decision-making powers (Nghia 2006).

RRBO is one of the first RBOs which piloted NARBO's performance benchmarking service to improve its performance. It has also participated in NARBO's twinning programme with Japan Water Agency to further inspire the organization to strengthen capacities of key staff on water resources management.

After studies indicated that management would be more effective if targeted at a smaller scale, two sub-basins of the Red River — the Cau and Day — were chosen to test a scaled-down management approach. The Cau sub-basin was selected because it presented the challenge of sharing water between four lower provinces, as well as conflicts over the allocation of water from Nui Coc reservoir for irrigation, consumption in Thai Nguyen City, and recreation and tourism. Pollution was also a major problem. Tackling these issues required an integrated approach. In the Day sub-basin, the main problem was declining water quality and environmental concerns arising from domestic, industrial and agricultural pollution (Molle *et al*. 2009).

The IWRM approach was introduced in both sub-basins and selected upland provinces, along with strategic flood management in the Red River delta. Various activities at this smaller scale helped to improve overall management across the Red River basin.

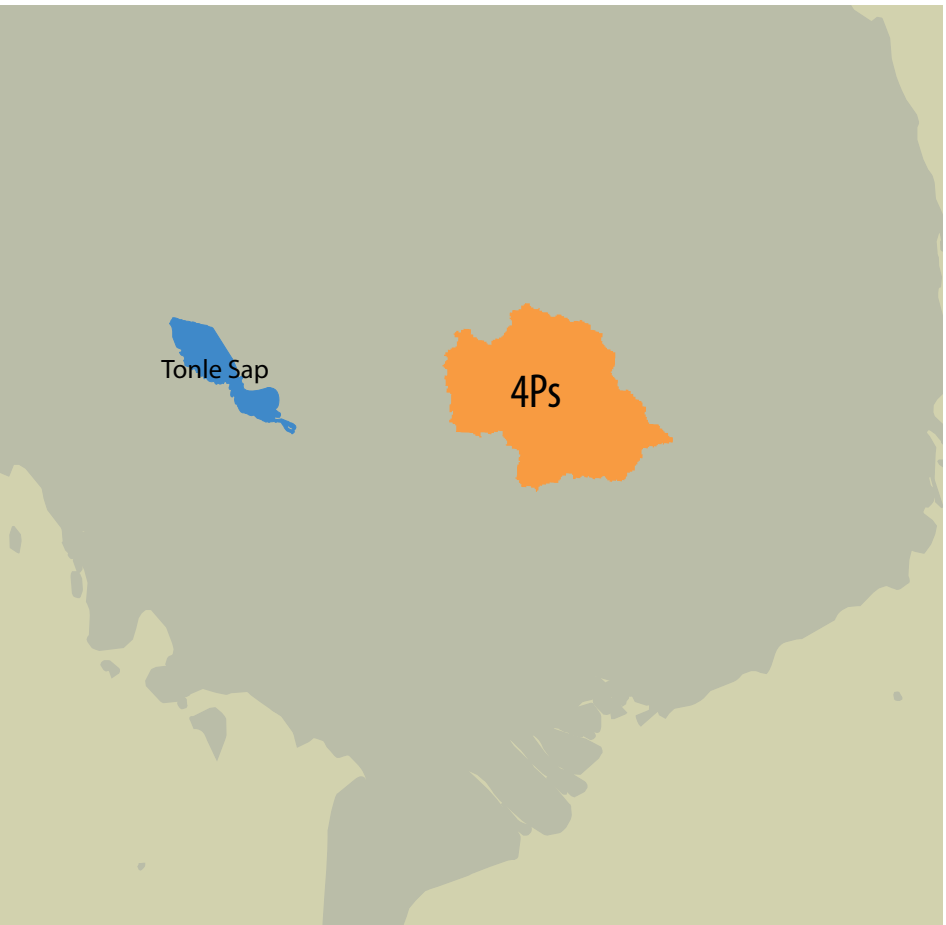
Dong Nai River Basin

The Dong Nai basin covers 11 provinces and two big cities — Ho Chi Minh City and Bien Hoa. Rising in the Lang Bia plateau of Lam Dong province, the Dong Nai River runs through Dong Nai province and flows into Tri An reservoir, where its waters feed a hydropower plant. The lower part of the river supplies water to Ho Chi Minh City and Dong Nai and Binh Duong provinces, but has been polluted by wastewater runoff from agriculture, aquaculture, industry and built-up areas (Ha *et al*. 2008).

To overcome these problems, a payment for ecosystem services (PES) project was launched in 2008 with the Danish International Development Agency (Danida) and WWF (Anon 2008). This was later named the Dong Nai River Basin Project and supported by IUCN, Winrock International and United States Agency for International Development (USAID) along with the Vietnamese government, local communities and the private sector. The project piloted fees for clean water for hydropower plants, government water companies and ecotourism operators. These fees were paid to government and distributed to the management boards of protected areas, state forest enterprises and local communities protecting upstream watersheds and catchment areas (Oliver *et al*. 2008). The fees are calculated on the basis of water users' outputs; for example, hydropower plants pay VND 20 (US$0.13) per kWh of electricity produced, and water supply companies pay VND 40 (US$0.25) per m^3 of water supplied.

An IWRM approach is helping to reduce pollution and protect water resources in the country

The revenue generated from these charges is shared three ways: 10% is retained by government agencies; 10% is given to the management boards of protected areas and state forest enterprises; the rest is distributed to households and communities holding contracts with the government and state enterprises for protecting the watershed (Clark 2008). The scheme currently generates US$2.8 million per year and covers 3,400 households. On average, each household is contracted to protect 20 ha of forest, for which it receives a yearly payment of US$500, an increase of 400% in average incomes. The success of the scheme is persuading local farmers to switch from crops such as cashew, which cause greater soil degradation and erosion, to high-yielding crops such as bamboo which do not have a detrimental effect on the environment (Phuc *et al*. 2010). ■



Cambodia's Water Law supports strategic investments in developing water resources, and promotes transparent, accountable and participatory water management

CAMBODIA

CAMBODIA RECEIVES 3,000 mm of rain each year, mainly falling in the months between May and November, leaving the rest of the year mostly dry. The livelihoods of most Cambodians depend on water, which also supports a large part of the country's economy. Agriculture and fisheries are still the two main sources of income, but as droughts and floods increase in frequency people are being forced to find other occupations (Botkosal 2009a).

Cambodia's Water Law was approved by the National Assembly in 2007. The law supports strategic investments in developing water resources and provides for transparent, accountable and participatory management. Other instruments supporting good basin governance are the Rectangular Strategy; National Strategic Development Plan; Poverty Reduction Strategy; Strategic Plan on Water Resources Management and Development; and National Biodiversity Strategy and Action. These focus on developing irrigation, improving agricultural production and building the rural economy. The Rectangular Strategy, for example, promotes the participation of communities and citizens in natural resource development. The Cambodia National Mekong Committee, in its capacity as a national coordinating agency for Mekong River issues, has recently been working with international partners to develop and implement basin management processes (Cambodia Development Research Institute 2008).

Keeping people in the centre of a water management strategy can help to alleviate poverty and protect the environment

4Ps River Basin

The 4Ps River basin consists of four sub-basins of the Mekong River — the Prek Preah, Prek Krieng, Prek Kampi and Prek Te — together covering 7% of Cambodia's land area. Located in eastern Cambodia, the basin is still mostly covered by forests. About 1% of the area is cultivated, and a quarter of this is irrigated. Poverty is still widespread and local people are vulnerable to floods and drought.

In 2007, a Functional Water Partnership — a network of focal points for dialogue on integrated water management — was formed in the four sub-basins. In a country which until recently suffered from instability and conflict, the 4Ps basin project was an important first step towards identifying key issues in planning for water resources management. The purpose of the dialogue launched under the Functional Water Partnership was to demonstrate an IWRM-based approach to basin management. The 4Ps Basin Coordinating Committee for Development and Management was established as an IWRM Committee, headed by two provincial governors and designed to encourage local stakeholder participation (Botkosal 2009b).

The 4Ps project focused on economic development and poverty alleviation, environmental protection, social development, flood and drought management, integration through basin planning, and water resources information management. It was successful in raising awareness of river basin management at provincial level. The Cambodia Water Partnership (CamboWP) and the 4Ps Basin Functional Water Partnership have been established as a result of this project. Coordination and cooperation have been promoted among different agencies involved in water management by engaging them in decision-making, planning, implementation, monitoring and evaluation. The support of senior decision makers has been mobilized for water governance by identifying key issues for water and other related resources, linked to broader goals for socio-economic development and environmental protection. ■

The 4Ps Project has raised awareness of river basin management concepts at the provincial level

An intergovernmental organization provides a framework for managing a major transboundary river basin

MEKONG RIVER BASIN

THE MEKONG RIVER is the longest transboundary river in Southeast Asia, and the twelfth longest in the world. Emerging from the Tibetan Plateau, it flows through PRC, Myanmar, Thailand, Cambodia, Lao PDR and Viet Nam before emptying into the South China Sea. Its basin covers 795,000 km^2 and comprises a large network of tributaries forming numerous sub-basins; the lower Mekong basin, for example, comprises 125 small and large watersheds (Snidvongs *et al*. 2006).

Over 100 different ethnic groups live in the Mekong basin, making it one of the most culturally diverse regions in the world. Almost without exception, their livelihoods depend on the natural resources of the basin. Agriculture is practiced in the middle basin in PRC, on the floodplains of Thailand and Lao PDR, and in the delta region of Cambodia and Viet Nam. Rotational farming is practiced in the eastern upland region of Lao PDR and southern Viet Nam. The southern part of the river in PRC, where it flows into eastern Myanmar, northern Thailand and northern Lao PDR, serves as a major fish migration and breeding ground. In Cambodia, the Mekong flows into Tonle Sap, the largest lake in Southeast Asia and an important habitat for capture fisheries, wildlife and tourism. The delta region is the most densely populated of the basin, mixing agriculture, industry, urban areas and nature conservation sites. Hydropower is generated in the southern part of the PRC and the upland region of Lao PDR and Viet Nam (Burma Rivers Network 2010).

The large tracts of forest and wetlands in the lower Mekong basin produce building materials, medicines and food, provide habitats for thousands of species of plants and animals, and support an inland fishery worth about US$2 billion per year. The Mekong basin is one of the most biodiverse regions in the world. More than 1,200

species of fish have been recorded in the river system, and more are likely to await discovery. This fish biodiversity supports a critically important fisheries sector and constitutes the main source of protein in the local diet. Some of the largest and most distinctive species found in the Mekong River and Tonle Sap Lake include the Giant River Carp or Jullien's Golden Carp *(Probarbus jullieni),* Mekong Freshwater Stingray *(Dasyatis laosensis),* Giant Pangasius *(Pangasius sanitwongsei),* Siamese Giant Carp *(Catlocarpio siamensis),* and Mekong Giant Catfish *(Pangasianodon gigas).* The Irrawaddy Dolphin *(Orcaella brevirostris)* was once common throughout the lower Mekong but is now classed as critically endangered. Other threatened mammal species found in and around the river system include the Smooth-coated Otter *(Lutrogale perspicillata)* and Fishing Cat *(Prionailurus viverrinus).* The basin is also rich in mineral resources such as tin, copper, iron ore, natural gas, potash, gemstones and gold. Most parts of the Mekong River are navigable except for a 14 km stretch in Lao PDR (MRC 2009).

Many of the critical issues in the Mekong basin are cross-border in nature, such as the impact on river flow from the construction of dams, canals and navigation improvements, and illegal trading in timber and other endangered plant and wildlife species (Pangare *et al*. 2006). Water and air pollution in the basin are localized problems. Basic sewage and drainage systems are often poorly maintained, and the major metropolitan areas suffer from serious air, surface and groundwater pollution. A particular problem is the uncontrolled disposal of industrial effluents including toxic and hazardous by-products from the growing industrial sector in many parts of the basin.

The Mekong River Commission

The Mekong River Comission (MRC) is an intergovernmental body established in 1995 under the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, signed by the four countries of the lower Mekong basin — Cambodia, Lao PDR, Thailand and Viet Nam. This agreement gave the organization — which started as the UN-founded Mekong Committee in 1957 — a new mandate to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River basin.

The upper Mekong countries of Myanmar and PRC are not members of MRC but maintain a dialogue with the organization on issues of mutual interest. In 2002, PRC signed an agreement on providing hydrologic information to MRC. It now provides data on water levels during the flood season from two of its stations on the upper Mekong.

The Governing Council of the MRC meets yearly, bringing together one representative from each member country at the ministerial or cabinet level. The Council makes policy decisions and provides guidance on the promotion, support, cooperation and coordination of joint activities and programmes under the 1995 Agreement. The Joint Committee consists of one member from each country at the departmental head level. It is responsible for implementing the policies and decisions of the Council, and supervises the activities of the MRC Secretariat. In effect this body functions as a board of management.

The Mekong basin is the most culturally diverse region and one of the richest areas of biodiversity in the world

National Mekong Committees coordinate MRC programmes at the national level and link the MRC Secretariat with national ministries and line agencies. The principal implementing agencies of MRC programmes and projects are the line agencies of its member countries. They are served by their respective National Mekong Committee Secretariats.

The Secretariat of the MRC has various divisions concerned with the environment, planning, technical support and operations. Its core areas of work are:

- Basin Development Plan
- Environment
- Information and Knowledge Management
- Integrated Capacity Building
- Water Utilization
- Flood Management and Mitigation
- Drought Management
- Agriculture, Irrigation and Forestry
- Navigation
- Hydropower
- Fisheries
- Tourism

The MRC is financed by its four member countries and by various bilateral and multilateral donors. A yearly Donor Consultative Group meeting provides a formal mechanism for consultation and coordination with the donor community (MRC 2009). ■

Specially appointed authorities have been set up in major river basins to control water pollution

PHILIPPINES

HEAVY POLLUTION OF rivers and lakes has had a major impact on the economy of the Philippines. Annual economic losses due to pollution have been estimated at PHP 67 billion (US$ 1.2 billion), of which PHP 3 billion are for providing health care and medication for pollution-related illnesses, PHP 17 billion are for losses in fisheries production, and PHP 47 billion are for losses in the tourism industry (ADB 2009).

Nationally, two regulatory agencies are responsible for water management — the National Water Resources Board (NWRB), for administering water rights and the Department of Environment and Natural Resources for pollution control. These functions are performed at the basin level by specially appointed authorities. There are several basin-based management agencies in the country.

The NWRB is the primary body for controlling, supervising, regulating and guiding the implementation of water resource management. In 2006, NWRB developed an Integrated Water Resources Management Plan which, together with an Integrated River Basin Management and Development Master Plan produced by the River Basin Control Office, established a framework for water management in the Philippines (Cabrido & Taylor 2009).

Laguna Lake Basin

Laguna Lake, the fourth-largest lake in Southeast Asia, lies in the provinces of Rizal and Laguna. The lake has one outlet through the Pasig River through Manila draining into Manila Bay. Increased development within the basin has caused water quality to decline steeply. To protect the lake environment, the government of the Philippines established the Laguna Lake Development Authority (LLDA) in 1966 (Pangare *et al*. 2006).

One pressing issue requiring the immediate attention of LLDA was that of increasing lake pollution. During the course of industrialization and urbanization, land use in the watershed surrounding the lake has changed substantially. As a result, about four million tonnes of suspended solids have been discharged into the lake, of which 20% has come from industrial activity, 70% from domestic sources, and a small percentage from deforestation (Nepomuceno 2007).

To exercise its authority in managing and protecting the lake, LLDA has taken several measures including introducing a pollution charge in 1997. Known as the Environmental User Fee System (EUFS), this is a market-based instrument designed to reduce water pollution from industry. There are two types of charges: a fixed fee includes the cost of administering the system; a variable fee is determined by the biochemical oxygen demand (BOD) loading, a measure of the amount of pollutants discharged into the lake. This variable charge allows industries to determine the amount of pollutants they are willing to discharge into the lake depending on their ability to pay.

During the first year of the EUFS, it was applied to five sub-sectors responsible for almost 90% of the total BOD loading in the lake: food processing, piggeries and abattoirs, beverages, dyes and textiles, and pulp and paper. These sub-sectors accounted for about 40% of the total daily waste discharge into the lake, or about 150 m^3 per day. Later LLDA expanded the system to cover all industries, housing developments and commercial establishments discharging wastewater into Laguna Lake. In 1999, the system was extended further to cover all restaurants and food outlets that discharged wastewater (LLDA 2003).

The EUFS is forcing industries to take pollution control measures to avoid a financial penalty for discharging wastewater. That it has been successful is evident from a decrease in the BOD loading of the lake as it passed the 5 mg/L Class C criterion, signifying good water quality (Anon 2009).

LLDA is an active member of NARBO and is also one of the four RBOs which piloted NARBO's performance benchmarking service. Knowledge sharing in NARBO activities, including training programmes and workshops, has motivated LLDA to improve its service and to develop staff capacities in managing the lake basin.

Davao River Basin

The Davao basin covers eight sub-basins and is the main source of water for Davao City in southern Philippines. The basin supports a rich range of resources and land uses, including urban areas, agricultural land, wetlands, mangroves, tree plantations and natural upland forests. It is also a major source of raw materials for food, medicine and cosmetics, and plays a crucial role in the economy of the country as a whole. The average per capita income within the basin is PHP 144,039 (US$3,320), far more than the national average of PHP 2,000 (US$46) (Hearne 2010).

However, the Davao River is under threat from pollution and reduced flows. Many initiatives have been undertaken by government and NGOs to tackle these problems, but have been weakened by a lack of coordination. They have operated under their own systems, policies and procedures, which are often in conflict. To streamline the management and implementation of these initiatives, the Davao River Conservation Coordinating Committee was established in 1999. This body sought to bring all initiatives onto one platform, but for political reasons it ceased operating in 2003.

Even after the committee was disbanded, local water stakeholders continued to work together, supported mainly by Catholic Relief Services. A local NGO, People Collaborating for Environmental and Economic Management, pioneered collaborative approaches to watershed management in the Talomo-Lipadas sub-basin, an important source of drinking water. The Davao City Water District has been leading a rehabilitation effort for its water sources which includes adopting integrated watershed management practices and establishing a Watershed Youth Management Council. Through these activities and strong leadership, a Watershed Code was drafted and adopted in 2007 to integrate the various initiatives in the basin (Hearne 2010).

The Environmental User Fee System introduced by the Laguna Lake Development Authority has helped to curb the pollution in the lake, making it safer for the local population

UNESCO-HELP set up the HELP-Davao Network in 2004 to promote integrated basin management. The Network which is a member of NARBO has supported activities aimed at defusing local water conflicts. In 2010 it focused on using international initiatives such as the International Year of Biodiversity to ensure that the local decision makers remained aware of the benefits of good water management and the risks of ignoring water problems. In 2010, the Network signed a memorandum of understanding with UNESCO establishing a new 3-year Davao Water Partnership to pool local resources and strengthen collaboration in IWRM and pioneered the spiral model of NARBO-UNESCO (Hearne 2010). ■

River basin management strategies in Malaysia are taking account of important habitats for endangered plant and animal species

MALAYSIA

ALTHOUGH MALAYSIA RECEIVES a high yearly rainfall of 3,000 mm, strong seasonal and spatial variability allows only 10% of this water to be used effectively. Some regions of the country face water stress, and the capital city Kuala Lumpur suffers from water shortages (Abidin 2004).

The country's 150 rivers have played an important role in shaping the culture and society of the towns and cities along their banks. Their basins contain important habitats for many rare and endangered species of flora and fauna. About 68% of Malaysia's land area is still covered by forests, while 22% is used for agriculture and 10% for mining and urban areas. Fifty six water supply dams and 11 catchments have been gazetted for supplying water (Zakaria & Selamat 2006). Pollution from domestic and industrial waste discharges, sedimentation, forest degradation and the loss of biodiversity are the major environmental problems facing the country. Flooding is also common.

Malaysia's National Water Resources Council is its apex body for managing water resources. The basin-wide approach to water management took root in 1999 with the formation of the Selangor Water Management

A river monitoring task force team patrolling Langat River

Authority (*Lembaga Urus Air Selangor*, or LUAS). Malaysia is currently formulating a National Water Resources Policy and National Water Resources Model Law to streamline basin management (Abdullah 2010).

Langat River Basin

The Langat basin lies in western Peninsular Malaysia, within the states of Selangor and Negeri Sembilan. It covers parts of the Klang River Valley, as well as the federal territories of Putrajaya and Kuala Lumpur. For long, agriculture and aquaculture have been the main sources of livelihood for the population of the basin (UNESCO 2010). The Langat basin has gone through major land-use changes. Forests and even farmland have given way to towns, cities and industries. Clearing of forests has led to flooding in low-lying areas of the basin. Water pollution has been worsened by the discharge of industrial effluents, domestic sewage from urban centres, and poor land management practices (Earth Observatory Center n.d.). Water from dams on the Langat River is supplied to major cities in the basin, including Kuala Lumpur.

In 1999, following a severe drought in Selangor and with new basin management laws coming into effect, LUAS was established as a one-stop agency for managing river basins and enforcing regulations at the state level. A Langat River Basin Task Force under the aegis of LUAS is responsible for issuing water abstraction licenses, monitoring pollution and managing inland navigation in the basin. The Task Force comprises representatives from LUAS, other agencies linked to the Langat River, representatives from industry and local communities, and research bodies such as the Institute for Environment and Development (LESTARI), an arm of Universiti Kebangsaan Malaysia. LUAS has solved 17 disputes concerning the river, most related to industrial waste discharges and dredging.

An important research initiative in the Langat basin has been the Land Use and Land Cover Change Project of the International Geosphere-Biosphere Programme. This was carried out in three phases from 1997 to 2002 with support from the Global Environment Facility (GEF), the National Aeronautics and Space Administration (NASA) and the Asia–Pacific Network for Global Change Research (APN). The project developed a methodology to monitor land use and land cover changes over time, and to identify and analyze the driving forces of those changes. This work focused on using remote sensing and geographic information systems (GIS) technologies, and socio-economic data, to explain changes in land cover. Land-use analyses

were carried out in the basin from 1974–2001, and standard international guidelines and methods used to sample water quality (Anon 2001).

As a result of this work, at least 30 years of data on land-use changes and water quality in the Langat basin are now available. The data on water quality from the past 20 years are comprehensive, with at least 20 parameters available for many river stations. Meteorological data are also available, as are data on hydrology and flow for certain stretches of the Langat River. This database is helping basin managers identify and apply better management solutions using an approach grounded on concrete information rather than estimates. The research in the Langat basin has also successfully integrated several analytical and modelling methods that could be useful to other institutions involved in managing basins (Anon 2001).

Kinabatangan River Basin

The Kinabatangan basin in Sabah, northeast Borneo, is home to intact rainforests, exotic animals such as the proboscis monkey *(Nasalis larvatus),* a series of distinctive oxbow lakes, and the indigenous river people known locally as *Orang Sungai.* The basin is also an important hub for palm oil production and, to a lesser extent, timber production.

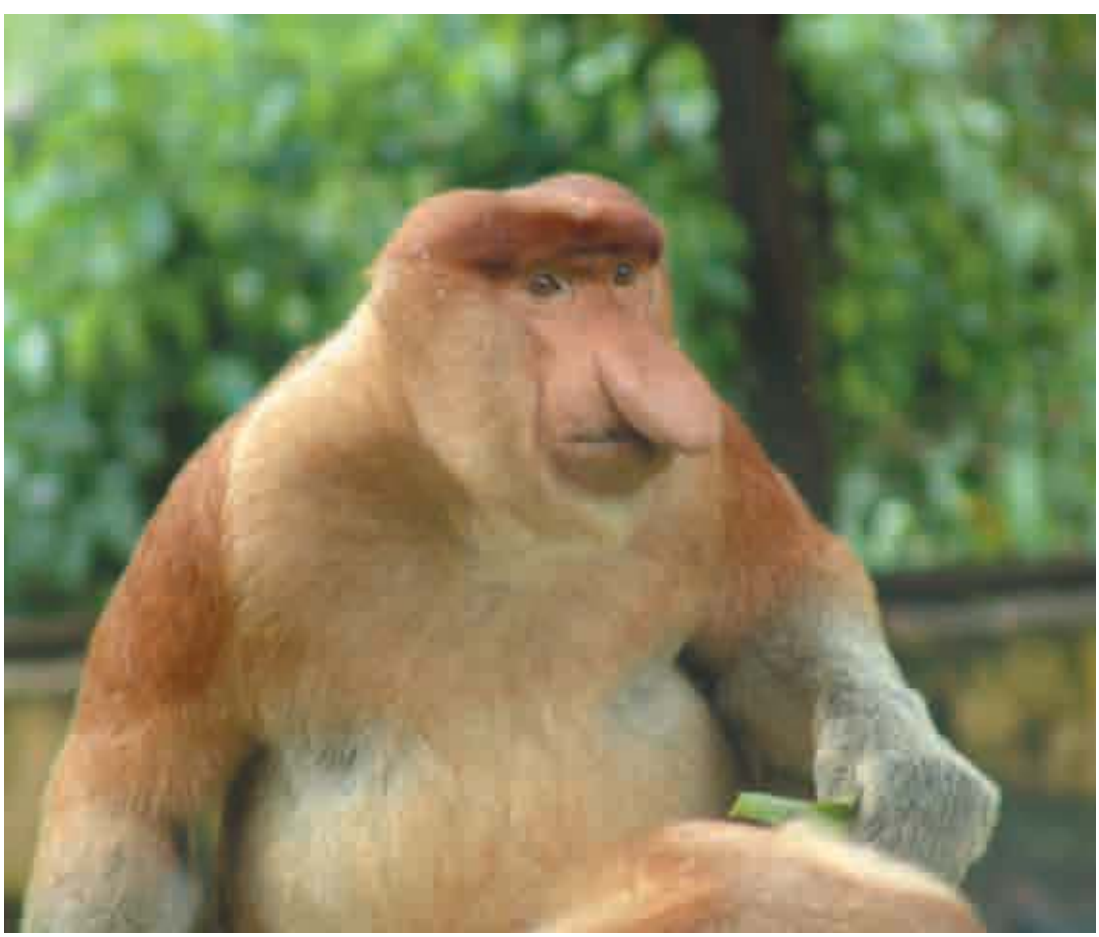
The Lower Kinabatangan region is rich in biodiversity, with waterlogged and dry forests, saline and freshwater swamps, and limestone forests. It has around 1,000 plant species and 50 mammal species, including primates, many endemic to the region. The Kinabatangan River is also the source of water for Sandakan, the second-largest city in Sabah, as well as surrounding towns and villages. The river is an important corridor for transport, trade and communication, and supports a thriving ecotourism industry. The Kinabatangan River flows into the Sulu Sea, notable for its high marine biodiversity and a popular diving spot (WWF 2010a).

Historically, Sandakan has been an important trading centre, depending mainly on timber harvesting and exports during the early to mid-20th century. Extensive logging led to the clearing of large areas of rainforest in the Kinabatangan basin. From the 1950s onwards, however, palm oil started to replace timber as the main economic activity. Thousands of hectares of palm plantations have been established in the basin, most by private owners, together with 29 palm oil mills.

The timber and palm oil industries have impacted on the biodiversity, geography and environment of the basin. Water quality has declined because of sedimentation from logged land, pollution from palm oil mills, and sewage discharged from residential areas. Flooding has increased, destroying palm crops, and, as cash crops have replaced natural forest, wildlife habitats have shrunk, leading to a rise in human-animal conflict. Once abundant plant and animal species have become endangered.

Conflicting stakeholder interests hindered the search for solutions to these problems, but by 2000, authorities and residents of the basin decided that the

The Proboscis monkey, Kinabatangan river basin



Communities living along the river have taken to rain water harvesting

best approach was to create a forest corridor to absorb flood waters and conserve wildlife habitats. A major obstacle to this measure, however, was acquiring the necessary land. Most of the land in the target area was privately owned, and some belonged to the forest department. Land had to be acquired by the wildlife department. Many plantation owners refused to part with their land, and some local people even opposed the project as they did not foresee any benefits for themselves.

After intense discussion and debate over a period of 5 years from 2000, some plantation owners gave up small patches of land to regenerate the forest for which they received financial compensation. A scarcity of seedlings of native trees turned out to be an income-generating opportunity for the local *Orang Sungai.* Nurseries sprouted up in villages to sell planting stock to the forest department for the newly acquired land. Villagers' interest in the project grew as they started to benefit from it.

As support increased for restoring forests and protecting wildlife, WWF and the Sabah Wildlife Department established the 26,000 ha lower Kinabatangan Wildlife Sanctuary in 2005 which also included the forest corridor. Over time, a constructive working relationship has been formed with many of the palm oil producers, and cooperation has grown between local communities, the government and the palm oil industry. Palm plantation owners have constructed an elephant bridge and an orangutan bridge to help these animals cross the river when water levels rise during the rainy season. They have also been persuaded to act as honorary wildlife wardens and help in patrolling the wild life sanctuary. Local communities take part in conservation activities and many villagers are now employed by the wildlife department. Tree felling has been prohibited, as have hunting and encroachment onto forest land. Although some of the restored forest areas have been closed to local use, several eco-lodges are run by communities, and some individuals have set up tour companies offering wildlife tours, river rafting, and other adventure sports (WWF 2010b).

Since the forest corridor is currently fragmented into ten sections, efforts are being made to acquire more private land to fill in the gaps and create a contiguous sanctuary. ■

Singapore's success in managing its water efficiently is evident in the domestic reduction in water consumption

SINGAPORE

SINGAPORE IS AN island city-state with no rural hinterland. The main island and some scattered islets on its northeastern and southern sides together cover an area of 699 km^2. Although the country receives an average yearly rainfall of 2,400 mm, its limited land area constrains the number of storage facilities it can build. The Singapore River and Kallang Basin catchments cover about one-fifth of the total area. The country's water reservoirs are able to meet about half of its demand; the rest is provided by recycling used water and importing water from Malaysia (Lee 2005).

The major consumers of water in Singapore are the domestic and industrial sectors. Fifty-three % of the total water supply is used by the domestic sector, and 43% by the commercial and industrial sectors. Per capita domestic consumption has been falling in recent years, a trend attributed to increased efficiency in water use.

Kallang River Basin

By the second half of the 20th century, rapid industrialization and urbanization had severely degraded water quality in the Singapore River and Kallang Basin. The Singapore River was devoid of aquatic life and considered ecologically dead. In 1977, Singapore drew up an action plan to tackle the ambitious task of restoring the river in 10 years. Under the plan, the government resettled more than 16,000 families from squatter colonies to housing estates, and relocated 2,800 industries to a new purpose-built industrial area. About 5,000 street sellers moved into specially constructed premises, and 610 pig farms and 500 duck farms were either closed down or relocated. Other polluting industries and trades also relocated to areas with proper pollution control measures. Lastly the city's sewer system

was extended across the entire Singapore River and Kallang Basin.

By 1987, the Singapore and Kallang Basins were largely restored. Awareness programmes educated the public against littering and discharging waste into the rivers. Legislation was enforced effectively, and regular inspections carried out to ensure that all wastewater is discharged into the sewer system, and that water treatment facilities are properly operated and maintained.

To keep the rivers clean, various engineering measures were adapted to minimize pollution. Vertical gratings were installed at selected outlet drains to prevent litter and debris entering the main canals and rivers. Float booms were installed at strategic locations to prevent waste from entering the Kallang Basin and Singapore River. The debris trapped by these gratings and booms are disposed of daily.

After the sources of pollution were removed, work began to improve the physical appearance of the rivers. The Singapore River was dredged and the waterfront renovated. A riverside walkway was built, and physical improvements were made to the 3 km stretch of beach along the Kallang Basin. Facilities such as river walls, piers, shelters and benches were installed to turn the surrounding area into a riverside park.

The restoration project was led by Singapore's Ministry of the Environment. A High Level Working Committee comprising various ministries and statutory boards was set up to oversee its implementation and monitoring. Besides these public bodies, the 10-year project also involved grassroots and civic organizations, the business community, and NGOs (Tay 2007). ■

Led by the Ministry of the Environment, the cleaning and beautification of the Singapore River and Kallang Basin was accomplished in 10 years with the help of government departments, grassroots and civic organizations, the business community and NGOs

Indonesia's water law requires 50% community participation in all water management planning

INDONESIA

INDONESIA IS THE world's largest archipelagic country, comprising 17,508 islands with more than 238 million inhabitants. Population growth, economic diversification, industrialization and urbanization are putting great pressures on the country's land and water resources, causing catchment degradation, erosion and sedimentation, and pollution of ground and surface waters. Floods, droughts, landslides and other natural disasters intensify these problems.

In 2004, the Indonesian government enacted a new law on water resources paving the way to introducing integrated management of water resources. The law mandates RBOs in Indonesia and regulates water conservation, water utilization and flood control. Indonesia has numerous river basin management bodies. The management of nationally important developed basins such as the Brantas, Citarum and Bengawan Solo has been devolved to self-financing, autonomous management corporations. For under-developed basins, provincial governments have set up permanent basin management units. Known as *Balai Pengelolaan Sumber Daya Air*, 42 such units are now operating across the country.

Citarum River Basin

The Citarum River basin lies east of the Jakarta metropolitan area, embracing a cluster of river basins covering 6,600 km^2. The resources of the basin's rivers and groundwater systems are essential to Indonesia's social and economic development — for urban and industrial development, including export-oriented industry; for agricultural production through major irrigation systems; for rural water supplies; for electricity generation though hydropower; and for fisheries (ADB 2009). Economic activities in the basin can contribute more than

Cleaning up activities are being undertaken in the Citarum river, lifeline of Indonesia's economic and social development

20% of Indonesia's GDP. Three hydropower plants sited in the upper section of the basin produce an aggregate of 1,400 MW a year. Irrigated farmland covers an area of 240,000 ha in the lower basin and 150,000 ha in upland areas. Irrigated agriculture yields about 3 million tonnes of paddy yearly, comprising 5% of national production. The basin also supplies 80% of Jakarta's raw water supply (Jasa Tirta II Public Corporation 2008).

The Citarum basin faces many challenges. The pressures on the Citarum river from rapid urban, agricultural and industrial development are high, and because of a lack of proper waste management, the Citarum is now one of the world's most polluted rivers. The Indonesian government has taken a number of steps to improve water quality, including introducing new regulations, setting environmental standards, and carrying out monitoring. The Jasa Tirta II Public Corporation (PJT II), a state-owned enterprise, is responsible for the overall management of the basin.

PJT II is one of the four RBOs which piloted NARBO's performance benchmarking service. Knowledge sharing in NARBO activities has further inspired this RBO to improve its service and to develop staff capacities in managing the Citarum river basin.

In 2005, the Indonesian government launched an IWRM programme in the Citarum basin with financing from ADB. This initiative was also the first river basin programme to be financed through an ADB Multitranche Finance Facility (MFF), a long-term investment programme for developing and managing infrastructure which provides financing that can be converted into smaller packages to fit specific project components. MFFs allow for flexibility in long-term investments, and foster the multi-sector involvement needed to implement an IWRM approach (ADB 2009).

The strategic framework for the initiative was developed with a broad range of basin stakeholders to produce an inclusive and transparent IWRM road map. In keeping with the 2004 water law, which requires that there should be 50% community participation in decision-making, local communities and civil society groups were included in this process. The road map, developed with leadership of Indonesia's National Planning Agency, comprises a set of strategies, actions and projects that must be implemented to achieve the basin vision defined as "the government and communities working together for clean, healthy and productive catchments and rivers, bringing sustainable benefits to all people of the Citarum river basin."

The components of the IWRM programme include: Jakarta bulk water supply; rice intensification system; community water and sanitation; environmental planning for water quality; solid waste management and composting; institutional mechanisms; GIS; and strategies for climate change mitigation and adaptation. A PDA was completed for the development of a water quality monitoring and management system for the West Tarum canal, and for the development of a compensation mechanism to protect the Citarum watershed.

Bengawan Solo Basin

The Bengawan Solo basin is the largest on the island of Java. Administratively it is shared by two provinces, Central and East Java, and is jointly managed by Jasa Tirta Public Corporation I (PJT I) and *Balai Besar Wilayah Sungai Bengawan Solo* (BBWS-BS). PJT I manages, operates and maintains the basin's water infrastructure, whereas BBWS-BS is responsible for basin-level water resources planning (Sudarsono 2009). Since the river basin covers two provinces, ensuring cross-boundary coordination to address the various problems has been a challenge. Historically no mechanism has existed for stakeholders to communicate and discuss their concerns and ideas for improving basin management.

The Water Council of Bengawan Solo basin, established in 2009, is responsible for identifying the needs and

The National Water Initiative (NWI) has catalyzed an integrated approach to planning, managing, measuring, pricing and trading water (Tasman 2005). NWI plans to achieve a favourable market, regulatory and planning-based system for water resources for both rural and urban areas. Under this initiative, each state requires to prepare an NWI implementation plan (NWI 2010).

Murray-Darling River Basin

The Murray-Darling basin is the largest river system in Australia, spanning about 14% of its territory. It consists of the country's three longest rivers: the Murray, the Darling, the Murrumbidgee and their tributaries (Department of the Environment, Water, Heritage & the Arts 2010). The management and allocation of the basin's water resources have been a point of contention for many years. Discussions on a joint agreement between the states sharing the basin began in the 1860s. In 1915, the River Murray Waters Agreement was signed by the federal government and the states of New South Wales, Victoria and South Australia. This established the River Murray Commission to oversee river management and water sharing (Murray Darling Basin Authority 2010). Over the next 70 years, various amendments were made to the agreement, gradually extending the Commission's powers to reflect social and economic changes. Amendments in 1982 and 1984 also gave the Commission some limited environmental responsibilities (Hooper 2008).

Despite these measures, degradation of the basin's resources accelerated during the 1980s. More than half of the original vegetation was cleared, and river siltation, salinization and biodiversity losses worsened. The responsibility for managing programmes in the basin at this time lay with five different state governments, all with limited coordination mechanisms in place for remedial programme development. To address this problem, the Murray-Darling Ministerial Council was created in 1985 to bring together ministers holding land, water and environmental portfolios in their respective states and territories. The Murray-Darling Basin Commission was set up in 1988 to support the Council. The Commission took responsibility for managing the water of the River Murray and lower Darling River, advising on policies and programmes for managing the Murray-Darling basin's environmental resources, and overseeing the implementation of policies and programmes (Baldwin 2010). Under the Commonwealth Water Act of 2007, the Commission and its responsibilities were subsumed by the Murray-Darling Basin Authority (MDBA), which is now the sole agency for planning and management in the basin (MDBA 2010).

The transition to the MDBA has been characterized as one of governance, leadership and focus. Created to facilitate a conversation between the different jurisdictions controlling the basin, the MDBA's principal management instrument is the Murray-Darling Basin Plan. Published in 2010 and revised in 2011, the plan's key component is to divert 2,750 gigalitres of water from irrigation and other water uses to restore the environmental flows critical to the survival of the river system. It is hoped that restoring these flows will relieve the enormous pressures on the basin from over-allocation of water, prolonged drought, natural climate variability and climate change (Clarke 2010).

South East Queensland

The South East Queensland (SEQ) region is one of the fastest-growing urban areas in Australia. The construction of dams and weirs, and changes in land use and vegetation cover, has dramatically altered the hydrology of the region's basins. More than 15 major catchments exist in the region. Pressure from human activities and exploitation of natural resources has led to sedimentation, high nitrogen loads from sewage effluent

One of the important components of the Murray-Darling Basin Plan is to divert 2,750 GL of water from irrigation and other water users to restore environmental flows

Bengawan Solo river basin is the largest on the island of Java

opportunities for improving basin management, providing policy guidance, and undertaking strategic planning and implementation. The Council derives its mandate from the Water Resources Law and reports to the Minister of Public Works and the governors of Central Java and East Java provinces.

The Council is one of the first multi-stakeholder platforms for basin management in Indonesia. It has 64 members representing different agencies and organizations involved in water resources management in the basin at national, provincial and sub-basin levels. Half of these members are from the government and the other half from the civil society. Members are appointed for a five-year term.

The Council has three commissions, each addressing a different set of issues: water conservation, water utilization, and control of disasters (such as floods and landslides). Thematic working groups have been established under each commission. In less than six months after its formation, the Council was able to draft a strategic plan for official endorsement. Early experience indicates that the Council is serving its purpose well, providing practical and useful guidance in active collaboration with stakeholders.

The Council provides insight and direction to water resources management and water-related development of the basin. A PDA was completed in 2009 which formulated a framework for better conservation and improved management of raw water sources through collaboration among four water utilities.

Brantas River Basin

The Brantas basin in East Java supplies water to about 16 million users, but suffers from poor water quality due to rapid population growth and industrialization. To tackle growing pollution, PJT I, the basin's autonomous management corporation, has developed a monitoring system with three components: stakeholder reporting, water quality sampling, and routine inspection.

Stakeholders in the Brantas basin play an important role in monitoring river water quality. In 1989, PJT I and the East Java provincial government jointly conducted the Clean River Programme (PROKASIH) to encourage public participation in monitoring and reporting incidences of pollution. NGOs, educational institutions, local communities and the media were engaged through information campaigns to apply social pressure on industries failing to meet their pledged discharge reductions (PJT I 2002).

PJT I samples water quality in collaboration with the Indonesian Institute of Sciences, through a network of 23 continuous monitoring stations. These stations, in operation since 1999, provide real-time data on water quality through an online hydrologic information system. Manual water quality sampling is also conducted monthly at 60 selected points along the Brantas river, and at 57 potential industrial pollution sources (Atmojastomo *et al*. 2003). PJT I also employs officers to conduct routine inspections of the river.

PJT I is a champion of NARBO's performance benchmarking service in Indonesia and the region, and has inspired many RBOs to improve their service and to develop staff capacities. ■

Lahor reservoir in the Brantas basin

Australia's National Water Initiative increases water use efficiency for greater savings, productivity and environmental performance

AUSTRALIA

AUSTRALIA'S RAINFALL AND river flow regime reflects the diversity of the continent. Rivers in the south of the country have been dammed extensively to meet demands for water from agriculture and urban development, whereas most rivers in Australia's tropical and subtropical north, which has two-thirds of its surface water, are largely unmodified by water development schemes. The two main exceptions to this are rivers in coastal Queensland and the Ord River in northwest Australia (State of the Environment Committee 2006).

Australia is the world's driest inhabited continent, and drought is a common occurrence. Irrigated agriculture is the largest consumer of water, accounting for two-thirds of total consumption. Demand is increasing in all sectors, however, putting great pressure on river systems and water regimes. Drought, increasing withdrawals of groundwater and habitat losses have worsened the situation in many catchments.

Despite these pressures, efforts by the Australian government to manage river basins and water resources wisely are bringing results. Various environmental projects, such as environmental flow allocation, habitat restoration and invasive species control, are helping to maintain water regimes. The government's efforts to engage local communities in water resources management have also helped to increase understanding and cooperation for protecting these resources.

The Ecosystem Health Monitoring Programme releases an Annual Report Card that assesses and rates the health of South East Queensland's waterways

and agricultural runoff, and other serious water quality problems in these areas.

In 1993, the Brisbane River Management Group was established by the community, government and industry to tackle these problems, later followed by the preparation of the SEQ Regional Water Quality Management Strategy (SEQRWQMS). In 2002, government, industry and community stakeholders developed a joint management approach to understanding and managing the region's waterways. The SEQ Healthy Waterways Partnership was launched as a multi-stakeholder programme to undertake activities such as upgrading sewage treatment plants and rehabilitating natural habitats. These actions have been underpinned and informed by a multidisciplinary research and monitoring programme (Bunn *et al*. 2007).

As part of the SEQRWQMS, a clear vision for the region's waterways was elaborated through a broad consultative process. This states that "by 2020, waterways and catchments will become healthy ecosystems supporting the livelihoods and lifestyles of people in SEQ, and will be managed through collaboration between community, government and industry".

One of the hallmarks of the Partnership has been the development of a comprehensive aquatic Ecosystem Health Monitoring Programme (EHMP) for the region's waterways. The information collected by the EHMP is used to advise councils and land managers on areas of declining health, to report on the effects of different land uses, and to evaluate the effectiveness of management actions aimed at improving and protecting aquatic ecosystems (Bunn *et al*. 2007).

The EHMP releases an annual report card for the region, rating the health of its waterways from A (excellent) to F (fail). The Partnership relies heavily on this tool to evaluate and communicate environmental conditions, and to provide the impetus for protecting and restoring waterways.

Public awareness about the Yarra River was heightened through a long-term media campaign titled "Give the Yarra a go."

Yarra River Basin

The Yarra basin lies in a drought-prone region of the southern state of Victoria. The state capital Melbourne is positioned at the estuary of the Yarra River, from which it obtains 70% of its water needs. Over-extraction of water, damming and pollution have contributed to reducing the quantity and quality of water in the river.

To raise awareness of the importance of conserving the Yarra, a local newspaper, The Age, ran a long-term campaign from 1969 to 1985 under the slogan "Give the Yarra a go". During the 100th anniversary celebrations of the newspaper in 2006, the Yarra campaign was declared the most successful in the paper's history. Running a daily article on water during the campaign had a major impact on public awareness and has helped convert Melbourne into a "water-sensitive" city (Department of Sustainability and Environment 2006). ■

In the face of freshwater scarcity and uncertainty over the impacts of climate change, the Pacific Islands are adopting innovative water management solutions

PACIFIC ISLANDS

THE PACIFIC ISLAND states are particularly vulnerable to climate change and rising sea levels. Their freshwater resources, already insufficient to meet demand, are under pressure from growing populations, urbanization and deforestation. Floods, droughts and cyclones are common. In many places, sanitation is inadequate and sewage effluent is degrading water quality (South Pacific Applied Geoscience Commission, SOPAC 2007). To deal with the problems, some countries have adopted innovative schemes, for example the Sustainable Integrated Water Resources and Wastewater Management project developed with UNDP, the United Nations Environment Programme (UNEP) and the Secretariat of the Pacific Community (SPC). The purpose of this project, which is being implemented across 14 countries, is to implement an integrated approach to addressing problems of freshwater conservation and sanitation.

The Marshall Islands

The Republic of Marshall Islands consist of 29 atolls in two island chains, comprising 1,225 islands with a total population of 70,000. About 70% of Marshall Islanders live in settlements on the main atoll of Majuro. Rainfall varies considerably between the islands and from year

to year. Droughts are associated with Pacific warm (El Niño) episodes. The country's freshwater sources include rainwater, groundwater and desalinated water, as well as water imports. Groundwater resources are polluted by inadequate waste treatment facilities, a limited sewage and sanitation system, and poor awareness and enforcement. Piggeries, cemeteries and landfills are also important sources of groundwater pollution (SOPAC 2007a).

The community of Laura at the western end of Majuro covers about 1.8 km^2 and is still largely rural. Its residents cultivate banana, taro, breadfruit and coconuts. Because catchment availability is limited in this part of the atoll, rainwater is harvested using the Majuro airport runway as a catchment area. The total catchment area for the atoll is about 800 km^2. Water from the airport is pumped to a series of reservoirs holding more than 140,000 m^3 of water, supplemented by groundwater pumped to the reservoirs from seven wells in Laura village. Water from these reservoirs is distributed through a piped drinking water system throughout the Majuro atoll (SOPAC 2007a).

The government of the Marshall Islands is working to improve water resources management by reducing groundwater pollution. To this end, the national environmental protection authority, the SPC's Applied Geoscience and Technology Division, the Laura Lens Integrated Water Resource Management Committee, and the National Water Resource Group are gathering information, raising public awareness and engaging communities in protecting the land and drinking water sources around Laura.

Palau

Palau is an archipelago of six island groups with more than 200 volcanic and limestone islands. The annual rainfall on most of these islands exceeds 3,500 mm. Perennial streams exist on the volcanic islands, but

Harvested water from the runway at Majuro airport

groundwater is the main source of water on the limestone islands, supplemented by water from rainwater catchments where available. The Palau Water Authority is responsible for water and sewage across the country, and serves 90% of inhabitants with a piped supply of freshwater. The increasing number of tourists visiting Palau has put a strain on both water supply and wastewater treatment systems. Stresses are also caused by warm El Niño events which extend the dry season to three months from its usual one and a half months (SOPAC 200b).

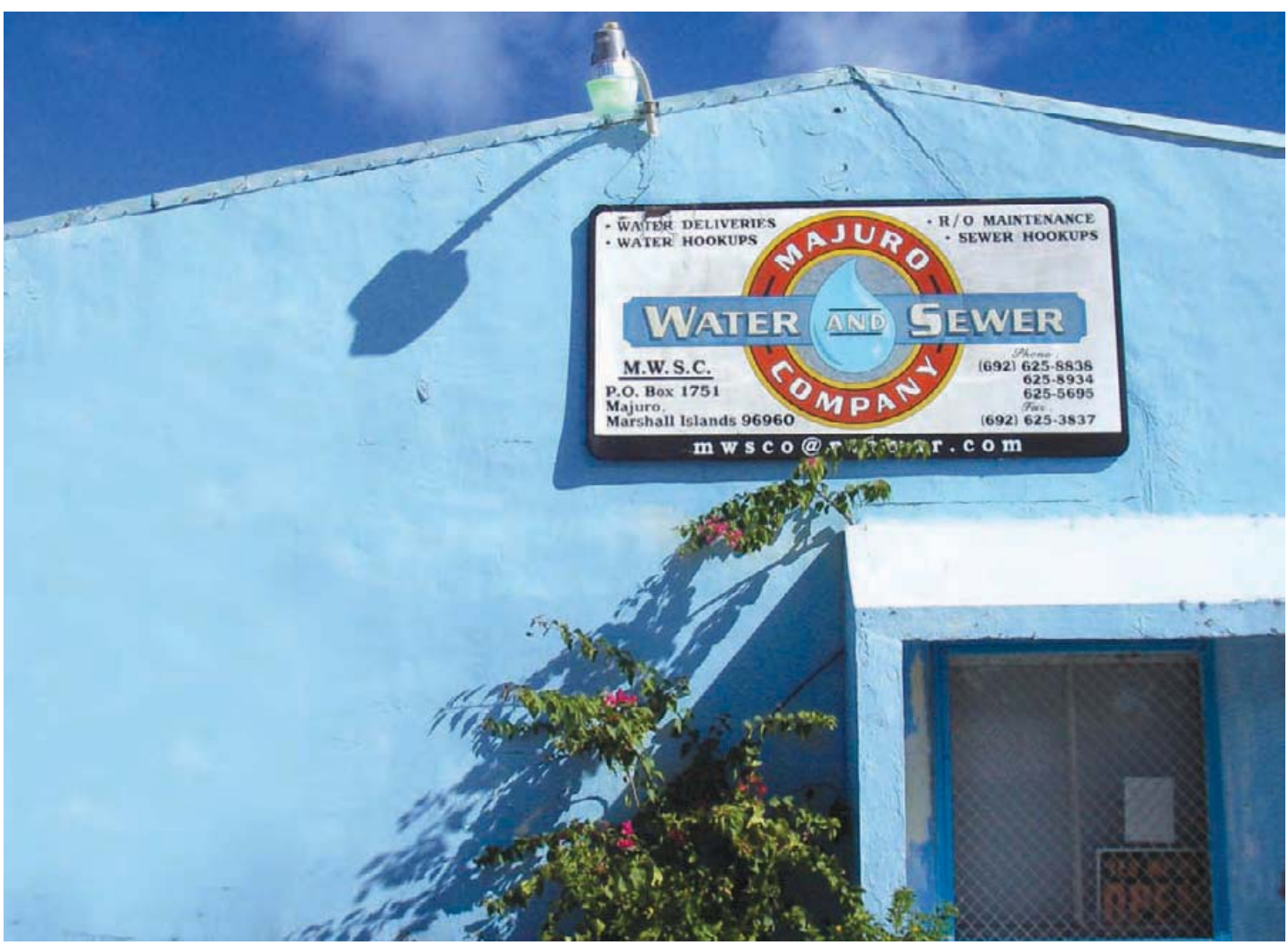
The Ngerikiil watershed on the island of Babeldaob covers 28.5 km^2 and provides drinking water for the islands of Airai and Koror, together accounting for 78% of Palau's population. Problems in this watershed include soil erosion and sedimentation caused by population growth and the encroachment of farm plots into the watershed area; chemical runoff from farmland exacerbated by weak monitoring and compliance; disposal of solid waste which is eventually washed into the sea; invasive species; and the loss of wildlife habitats.

Preserving natural terrestrial habitats and its rich marine environment is vital to Palau, since tourism is an important source of revenue for the island nation. The government of Palau, along with local communities and civil society groups, is protecting the watershed by controlling land degradation, preserving soil stability and limiting agricultural runoff to protect terrestrial habitats and the marine environment. Road runoff is being monitored and drainage is being improved. Native plant species are being reintroduced in degraded areas. These efforts are beginning to show positive results in erosion control with local communities driving the process. Land use planning and environmental health monitoring are also helping to reduce marine pollution (SOPAC 2007b).

The Solomon Islands and Vanuatu

The Solomon Islands consist of nearly 1,000 islands, ranging from low-lying coral atolls to heavily forested mountainous islands. Rainwater harvesting and groundwater aquifers provide freshwater for the small islands; the larger ones rely on rivers, streams and other surface water. Timber harvesting and traditional shifting cultivation have drastically altered freshwater regimes in many parts of the country. Water conflicts among clans, tribes and other landowners stemming from unclear water rights are common. Leakage in urban water supply systems is estimated at 70-80% (SOPAC 2006). To tackle these problems, the government is currently developing appropriate legislation to bring together different stakeholders under a common strategy for water resources management.

Many Pacific islands are now having water utilities to manage their drinking water and sanitation



Vanuatu is a volcanic archipelago of 80 islands in the South Pacific Ocean. Many of these are mountainous islands with steep, heavily-forested terrain. Coconut plantations and agricultural fields occupy their narrow coastal plains. Some of the larger islands have surface and groundwater resources, but some of the smaller ones have only surface water or no fresh water at all. Groundwater from shallow aquifers and surface water are both widely depended on for domestic use, though the use of groundwater is largely unmonitored. Piped water supplies are available in urban areas; in rural districts water supplies are largely donor-funded and managed by local communities.

Vanuatu's Water Resources Management Act No. 9 of 2002 provides for the protection and management of its water resources. The Act upholds customary rights of land tenure and resource ownership as defined in the country's 1980 Constitution. It is administered by the Department of Geology, Mines and Water Resources of the Ministry of Lands and Natural Resources. Under the Act, a National Water Resources Advisory Committee with government, NGO and private sector membership is charged with providing policy guidance, overseeing planning and development of water supplies, and coordinating water management activities. Although progressive, the Act has proved hard to implement because of a lack of awareness and policy direction for water resource management (SOPAC 2007c).

To help the Solomon Islands and Vanuatu build awareness and understanding for managing water resources, the NGO Live & Learn Environmental Education provided education for sustainable river and water conservation between 2003 and 2004. Financed by ADB, this project encouraged participatory learning and monitoring in two river basins in Vanuatu and two basins in the Solomon Islands.

Communities and schoolchildren from the Guadalcanal watershed in the Solomon Islands, and Efate in Vanuatu, were trained to use water-testing kits, monitoring handbooks and various visual aids. These methods were successful in raising awareness about water pollution and fostering a high level of participation, especially amongst children. Project participants designed action plans to continue monitoring in their watershed areas. In Honiara, Solomon Islands, a Water & Youth Network was formed to engage with government and influence policy by demonstrating good practice in water management. In Vanuatu, where the project's links with government were stronger, its activities were integrated into the environmental management plan for the Tagabe watershed (Live and Learn Environmental Education 2004). ■

New Zealand is optimizing the contribution of its water resources to its economic, social and cultural well-being

NEW ZEALAND

NEW ZEALAND'S LOCATION and topography have given it a complex, variable climate. Although the country has abundant rainfall, there are great seasonal and geographic variations in precipitation.

Owing to its mountainous terrain and the narrow breadth of its two main islands, New Zealand's rivers flow swiftly down steep slopes, quickly reaching their outlets at the sea. These rivers feed numerous lakes formed either by volcanic activity or by glacial retreat. Waikato River on North Island, at 425 km, is the longest river in the country; Clutha River on South Island has the largest basin with a catchment area of 21,960 km^2 (Ministry for the Environment 2007).

New Zealand is optimizing the contribution its water resources make to the country's economic, social and cultural well-being. Although some lakes, rivers and wetlands are protected as national parks, many are used for irrigation, hydroelectric power, industry and domestic consumption. Water is considered a public good, and is managed by regional councils according to regional policies and plans which determine permissible activities based on their environmental effects.

New Zealand began establishing river boards as early as 1868, and catchment boards by 1945. Under the Water and Soil Conservation Act of 1967, the management role of catchment boards was extended, reshaping them into regional water boards. During the 20th century, numerous acts were passed dealing with flood control, soil conservation, water allocation, community water supply, water quality management and water conservation. In 1991, the

Resource Management Act repealed over 60 acts and amended 150 others, transforming the fragmented water management system into a more integrated regime for air, land, water and ecosystem management (Davis & Threlfall 2006).

The Resource Management Act identifies a number of nationally important management functions:

- preserving the natural character of the coastal environment, wetlands, lakes, and rivers and their margins;
- protecting these areas from inappropriate splitting up, use and development;
- protecting outstanding natural features, large areas of native vegetation and important habitats of native fauna;
- maintaining and enhancing public access to coasts, lakes and rivers; and
- maintaining and enhancing of the relationship of the Maori people and their cultural traditions with their ancestral lands, water and sacred sites.

Motueka River Basin

The Motueka Basin lies within the boundaries of Tasman district on South Island. Since the arrival of the Maori some 800 years ago, and Europeans in the 1800s, deforestation of the catchment has caused widespread sedimentation. Reforestation of about a third of the catchment with coniferous tree species in the 1990s reduced stream flows and groundwater recharge. Road construction and land clearing have caused further localized erosion and sedimentation in the river (Sinner *et al*. 2006). Other challenges to managing the basin, which supports an internationally renowned wild trout fishery, are conflicts between water users, especially between the forestry and farming sectors; allocating surface and groundwater; declining water quality; and the impacts of catchment discharges on the coastal zone. The loss of native flora and fauna, and the spread of plant and animal pests, are also major concerns.

The Motueka Integrated Catchment Management (ICM) programme began in 2000 as a nine-year interdisciplinary, multi-stakeholder research programme on the effects of different land uses on water resources, water quality, habitat and riparian management, coastal and marine issues in the Tasman Bay, and conflict resolution. Integration and modelling also formed part of the research. The programme is a partnership between Landcare Research (a state research institute), the independent Cawthron Institute and the Tasman District Council, and is supported by UNESCO-HELP and New Zealand's state Foundation for Research, Science and Technology. A number of local authorities and private shellfish interests have also contributed financial support (UNESCO 2010).

Community involvement helped to save the catchment area of the river

The programme has focused on increasing local authority and community involvement in research by applying collaborative learning and action research approaches to sustainable management of the catchment and wider Nelson-Tasman region. It has provided information and knowledge in the following areas:

- factors influencing decision makers, resource users and the wider community;
- critical biophysical processes across land–water–coastal boundaries;
- tools for resource users and agencies to avoid, remedy or mitigate downstream impacts; and
- patterns of resource use and mitigation measures that resource managers can plan for, given likely development scenarios and available tools and knowledge (Bowden 1999).

Through the ICM programme, Motueka set an example which is being emulated across other basins in New Zealand. Its results are being promoted in all 16 of the country's regions, and by various government departments, including the Ministry for the Environment, Ministry of Agriculture and Forestry, and Ministry of Fisheries. ■

KEY MESSAGES

The Rationale for Integrated Water Resources Management

Prof. Malin Falkenmark
Senior Scientific Advisor
Stockholm International Water Institute (SIWI)

THE NEED FOR a minimum level of water security to support socio-economic growth has become increasingly clear in recent years. What this means, essentially, is security for crucial water-dependent activities and ecosystem functions. IWRM is a necessary component of the coordinated actions required in a river basin. The rationale for integrated management is that water performs a series of parallel functions: societal water supply, industrial development, biomass production (food, timber, fuelwood), energy generation and ecosystem maintenance. It is also a universal solvent, absorbing both natural substances and those introduced by humans as it flows through the basin.

The widespread confusion about IWRM suggests a lack of conceptual refinement and clarity in the term "management", due to the river basin's frequent unsuitability as a management unit. Yet water's role as an integrator during its passage from mountains to river mouth is a physical fact, and puts a spotlight on the drainage basin as a whole. It creates a need to allocate water among multiple uses along the river system, allowing also for other water-dependent functions and phenomena. That downstream aquatic ecosystems are the ultimate victims of upstream water-impacting activities also supports this view. All this calls for a basin approach as one component of good water governance.

The basic rationale for an integrated approach is the fact that the same water has a whole series of parallel functions in the basin; societal water supply, industrial development, biomass production (food, timber, fuelwood), energy production, and habitat for aquatic ecosystems.

Infiltrated rainwater must also be considered

In the past, water managers' interest has centred on blue (liquid) water, overlooking the benefits and problems of green (infiltrated rain) water in the soil. They have also underrated the role in management of the water in food and biofuel production, and in terrestrial ecosystems. The link between land use and rainwater runoff argues for catchment-based IWRM to become ILWRM, adding an 'L' for land use and protecting vital terrestrial ecosystems. This would enable a compatibility analysis of different water-related activities and ecosystems in the basin.

Working towards internal compatibility

It is self-evident that actions must be well-coordinated, especially where water stress and water shortage are worsening. The many different forms of dependence on water, both for societal needs and for ecosystem health, make wise balancing a crucial aspect of effective governance. On the one hand, balancing is necessary in terms of conservation activities; on the other, in terms of making trade-offs between different interests. Its outcome should be a road map for sustainable use of the resource base, suitably linked to national economic planning processes.

When it comes to trade-offs, one key question is who should decide on balancing priorities among different stakeholder groups. Three main groups of trade-offs must be considered: urban/rural, upstream/downstream and humans/ecosystems. The links between upstream and downstream uses are still poorly understood, especially in relation to how upstream water and soil conservation practices affect runoff generation and thereby downstream water availability. To avoid river depletion, the consumptive water use required for food security must be balanced against the water needs of other activities and ecosystems. Food imports may be one way out of this dilemma in some basins.

Measures to protect aquatic biodiversity downstream may have to be applied upstream also to ensure a certain minimum water flow is maintained. This will be particularly important in basins with high levels of biodiversity.

Reasonable control

The linkages highlighted above imply that reasonable control must be exercised through a well-functioning governance system. Such a system should contain both centralized and decentralized components, and encompass both basin integration and sectoral coordination. The aim of this control is to secure water accessibility, avoid foreseeable problems and foresee future changes. Three elements make up good basin governance: balancing competing interests; adapting to foreseeable challenges in hydroclimate and water quality; and better handling of sharpening water shortages and constraints, river basin closure and other threshold-related phenomena.

Language and concepts must be clear
Many types of expertise are necessary for IWRM, and social acceptance of trade-offs calls for all relevant stakeholders to be involved. This need for inclusivity makes it essential to avoid any conceptual unclearness. Special attention must be paid to outstanding questions of what a concept really means, and to developing new or better concepts as problems arise. You cannot discuss a phenomenon without having a word for it!

Wetlands and River Basin Management: The view from Ramsar

THE CONVENTION ON Wetlands celebrated its 40th anniversary in 2011, having been signed in the Iranian city of Ramsar in February 1971. It now embraces 160 contracting parties and more than 1,900 wetlands of international importance, or "Ramsar sites". As the Convention has matured, its parties have come to recognize the need to provide national Ramsar authorities and wetland managers with guidance on meeting their commitments effectively – to plan for the wise use of their wetlands, to promote the conservation of their Ramsar sites, and to cooperate globally in achieving their common objectives. Since the early 1990s, the conference of parties to the Convention has adopted scientific and policy measures on a wide range of topics, ranging from developing national wetland policies and harmonizing regulatory frameworks for wetlands, to negotiating site management plans, fostering public participation in management, and restoring individual wetlands.

Wetlands must be a key topic of any broader discussion on water allocation and management. They are among the world's most productive environments, cradles of biodiversity supplying the resources on which numerous plant and animal species depend for their survival. They provide essential habitats for birds, mammals, reptiles, amphibians, fish and invertebrates, and are storehouses of genetic material. The many roles of wetland ecosystems and the ecosystem services they provide – freshwater supply, flood control, groundwater recharge and climate change mitigation among others – are indispensable to society as we know it.

Early in the life of the Convention, its parties realized that protecting wetland resources could not be considered in isolation from other resources. The health of wetlands and the sustainable use of their benefits, depend on a complex web of links with their environment at different geographic and hydrologic scales. Over the years, water resources and wetlands have tended to be the responsibility of separate agencies, often with different objectives and methods. This has led to enduring conflicts over water use and river basin management, not to mention needless inefficiency, and sadly wetlands have not always been given the priority they deserve for their role in maintaining healthy and productive river systems.

For these reasons, the Ramsar Convention has long striven to interpret problems and develop solutions using a multi-sectoral, ecosystem-based approach, and to encourage its wetlands constituency to reach out to other sectors for ideas and support. And, conversely, it has sought ways to ensure that water allocation planners and basin management authorities recognize the importance and values of wetlands.

As early as 1996, the pioneering *Ramsar and Water* report stressed that "wetlands, because of their ecological and hydrologic functions, are an intrinsic part of the overall water resource system and should be managed as a component of such", and noted the "need for planning at the river basin scale which involves integration of water resource management and wetland conservation". In 1999, the parties adopted the *Guidelines for Integrating Wetland Conservation and Wise Use into River Basin Management,* which set out clear steps for reaching beyond the wetland sector. These were augmented in 2005 with guidance on "hard-wiring" water-related management objectives for basin wetlands into the business and operation plans of relevant management agencies. Most recently, in 2008, the parties adopted the *Changwon Declaration* to target decision makers outside the Ramsar community with the message that "instead of being demand-driven, which promotes over-allocation of water, water governance should treat wetlands as our 'natural water infrastructure', integral to water resource management at the scale of river basins".

In future years, as demands on water continue to grow, achieving the goal of sustainable use of freshwater resources will require new approaches to water and river basin management. In view of the important roles that wetlands can play in these efforts, integrating their conservation and wise use into river basin management will be indispensable to maximizing and sustaining the benefits they give us.

The Ramsar Convention on Wetlands commends the good work of IUCN and its other partners in furthering its goals. Together with its supporters, it will continue to strive for a universal understanding of the need for sound basin management systems that fully acknowledge the importance of wetlands.

Anada Tiéga
Secretary General
Ramsar Convention on Wetlands

Considering the important roles that wetlands can play in these efforts, the integration of wetland conservation and wise use into river basin management is indispensable.

The Role of River Basin Organizations (RBOs) in IWRM

Dr Apichart Anukularmphai
Senior Advisor
Network of Asian River Basin Organizations (NARBO)

THE CREATION OF RBOs aims to empower stakeholders to play a full part in decision making and management for basin water resources. The purpose of such participation is not necessarily to produce a basin plan, but rather to promote of awareness and changing attitudes about managing water resources effectively to improve livelihoods and ecosystems.

IWRM is a globally recognized approach towards better water resources management, a process covering enabling environments, institutional arrangements and management tools. Through case studies and observations of water resources management in Southeast Asia, the success of RBOs has been shown to stem from performance rather than specific organizational arrangements. At the same time, applying IWRM successfully depends not on following a rigid formula, but on adopting adaptive processes leading to gradual changes in attitudes, behaviours and management practices.

For these reasons, establishing strong RBOs and implementing IWRM are both long-term, dynamic and, to some extent, unpredictable processes. They require flexibility, innovative thinking and active participation from government, civil society and other sectors. The challenge can be compared to solving a jigsaw puzzle, where, by trial and error, the many separate pieces are put into their proper places to form a complete picture.

Managing River Basins in the 21st Century

Colin Chartres
Director General
International Water Management Institute

MUCH HAS BEEN written about integrated water resources management (IWRM) over the past 50 years, but relatively little has been put into practice. Notable examples of countries adopting IWRM principles in river basins are few and far between. Even in the Murray-Darling basin in Australia, where planning has been centralized at the federal level, the individual states do their best to manage water in their own interests rather than those of the basin as a whole. Similarly, the Mekong River Commission has few, if any, powers over controlling development in the Mekong basin, and a key player, the PRC, is not even a member. In Africa, the northern Nile basin states continue to squabble with their southern neighbours, and few of the continent's other large basins have strong authorities. In Europe, where water scarcity is generally a minor issue, some progress has been made in controlling floods and improving water quality in the major basins, but much remains to be done. Strong state control over water in the United States, and to some extent in India, often means that questions of subsidiarity hinder broader scale planning. Lastly, even though groundwater is usually linked to surface water, in many jurisdictions it is regulated by a different agency from those that manage surface water, or not managed at all.

In view of the important roles that wetlands can play in river basin management, integrating their conservation and wise use will be indispensable.

The principles of IWRM are sound. The problem is that insufficient thought has been given to how they can be practically implemented. In many countries, the laws defining water rights and rights holders are either too simplistic, unenforced, or simply absent. I believe that improving water governance is the critical challenge for legislators in the 21st century, and a vital step towards implementing better basin management. Good water governance systems not only define water rights, they also clearly show how water can be moved from one person to another, or one sector of the economy to another, based on fitness for use and market value. Further, power over planning and allocation of water must be vested in one agency, ideally a national or basin-level one, rather than a plethora of departments as is usual in many jurisdictions. At the same time, information must be supplied to water users, planners and policy makers to help them make informed, evidence-based choices about how and where water should be used and how the environment should be protected. Few countries have invested adequately in water information systems to meet this need. Where basins cross political boundaries, international basin authorities with powers to facilitate water-sharing agreements are essential. We badly need innovation in water governance to deal effectively with water issues, irrespective of sectoral differences and in line with our evolving scientific understanding of basin dynamics.

The widening gap between water supply and demand in many countries is both a cause for concern and a cause for optimism, since increasing pressure on the resource could stimulate calls for better governance and management. With luck this demand will materialize and the isolated examples of good basin management described in this publication will be adapted by policy makers and water managers everywhere. If it does not, increasing competition and corruption will inevitably hurt both the poor and the environment as water is appropriated by those most able to afford it.

If we succeed in abandoning our business-as-usual approach to water, which grossly undervalues it, we could see much better managed water basins by the middle of this century.

Thoughts on River Basin Management in the Future

RIVER BASIN MANAGEMENT in 2060 or beyond will constitute a paradigm shift from what traditionally has gone by the same name. Growing water demands must be reconciled with the limitations of the ecosystem services performed by the hydrologic cycle. Doing this will mean moving from unitary water resource management to interdisciplinary water systems management, a transition several developed countries are already making. The paradigm emerging from these efforts is based on an ecosystems perspective and a comprehensive institutional framework for amicably resolving conflicting claims to water. In rapidly growing Asian economies such as PRC and India, a failure to make this shift will inevitably obstruct economic growth and lead to more water disputes and conflicts.

The main innovation centres on recognizing that no river is able to satisfy every water need in the basin or the country. Further, freshwater flows must be kept at required quality standards. The idea that the natural flow of a river can be divided into its environmental flow and a separate flow transferrable free of cost or damage is wrongheaded. The natural flow of a river is its environmental flow. Every drop of water makes an ecological contribution. Thus, the diversion of water from a river must be capped according to a reasonable and informed compromise between harming the natural flow and realizing the economic benefits from water storage and transfers. Any damage to natural ecosystems and their services must be assessed as accurately as possible and compensated for. This innovative idea has started to guide policy in many countries and, it is hoped, will do so soon in the Asia and the Pacific.

The Asia and the Pacific region is vast and climatically diverse. Its countries need to develop water science and policy, including supply and demand management strategies, tailored to their specific climatic and hydrologic conditions.

It is undeniable that large water projects, especially for irrigation, have succeeded in the region. Yet this approach has become entrenched as the temporary success of supply-side measures has been used to justify permanent solutions. It now needs to change in several fundamental ways:

- Ecological sustainability of the basin should be the central concern.
- Institutional sustainability for river basin management should be ensured. In several parts of the Asia and the Pacific region, participatory management of small watersheds has worked well to enhance the water security of small communities.
- All flows are environmental flows, and compensation for damage to ecosystem services should be an integral part of the assessment of water projects.
- Top priority should be given to domestic water supplies above other economic needs.
- Water pricing for economic uses should be a basic element of management.
- Laws against pollution and environmental damage must be enforced, for example through environmental courts.
- Better future scenarios of water availability are needed, taking special account of the potential impacts of climate change.
- Water science and engineering curriculums must be upgraded with interdisciplinary knowledge and concepts.
- All aspects of water management should be brought under one administrative authority, such as an RBO.

Prof. Jayanta Bandyopadhyay

Faculty

Indian Institute of Management

Hence both the establishment of a well function RBO and successful application of IWRM are a continuous and long dynamic process, it involves flexibility, innovative thinking and active participation from the civil society and Government.

IWRM in the Context of River Basin Management

THE PREVAILING CONCEPT of river basin management these days is inextricably linked to that of integrated water resources management. IWRM has become a universal goal. This is fine, provided it leads to meaningful action and is not simply used as a smokescreen to satisfy the international community or hide “business as usual”.

Addressing water resources planning and management within a basin context is increasingly taken as a starting point. This norm is generally accepted, and, though there have been many false starts in institutions intended to unite the diverse perspectives of different stakeholders (whether upstream or downstream, or urban or rural), some promising new initiatives based on administrative boundaries better reflect the realities of existing power structures. Yet many challenges remain, and we often over-simplify the picture by neglecting the interactions between ground and surface water or, as we are coming to realize in the Mekong basin, between the river system and the coastal zone. Coastal fisheries, for example, depend on nutrient-laden sediments from the Mekong river and its catchments.

IWRM conjures up a wide range of concepts and draws on many elements of good governance and sustainability, including equity, participation, accountability, transparency, balancing development and conservation, subsidiarity in decision making, and so on.

But we sometimes use the term IWRM too casually as our ultimate goal, without understanding the inevitable institutional barriers to its implementation. Or we put it on a pedestal and consider only perfect solutions as worthy.

Jeremy Bird

Former Chief Executive Officer

Mekong River Commission

Secretariat

We desperately need innovation in water governance that deals effectively with all water issues irrespective of sectoral approaches and consistent with scientific understanding of the dynamics of basins.

In practice, the end result of applying IWRM in a basin will mean different things to different stakeholder groups, rather than offer a single solution that appeals to all. Hence the importance of agreeing on what IWRM means in practice on a case-by-case basis; of managing expectations about the pace of change; and of adopting a step-wise approach to implementation.

In fast-growing regions such as the Mekong basin, the scale and pace of development generate potential conflicts between sectoral interests that demand a coordinated response. One example is the well-documented issues surrounding the impacts of dam development on migratory fish species and local livelihoods. Another is the concerns of downstream riparian stakeholders over increasing salinity intrusion due to upstream abstractions for irrigation. In more-developed basins, the pace of change may have lessened, but increasing societal aspirations for clean rivers and unpolluted lakes often drive the same need for cross-sectoral and cross-border dialogue and cooperation.

Two interesting challenges for the Mekong basin in the next 20 years are, first, how the institutions developed in the 1990s and earlier adapt over time, and, second, how MRC member countries demonstrate their commitment to greater ownership through increased financial contributions, gradually taking over from the MRC Secretariat in implementing basin-wide functions through regional working groups.

Putting accurate, relevant and independent information in front of decision makers and the general public is a key role of a river basin organization. A number of tools have been used for this purpose in the Mekong basin, for example common data collection programmes, jointly developed simulation models, the use of agreed development scenarios, and participatory basin planning and strategic assessments of cumulative impacts.

Financing is of course key to the sustainability of such an organization. Yet ultimately its success will be determined by the level of political commitment of its member states. The Mekong region is fortunate that, over the past 50 years, the mutual benefit of such cooperation has been clearly established by MRC member countries, and is set to grow even stronger with the recent demonstration of closer involvement by Myanmar and the PRC. Both of these upstream countries increasingly see benefits in constructive engagement.

A Legal Perspective on Future Directions in Basin Management in Asia and the Pacific

Stefano Burchi
Chairman of the Executive Council
International Association for Water Law (AIDA)

THE RIVER OR lake basin is nowadays widely seen as the preferred spatial unit for delimiting the physical jurisdiction of a national water resources administration, and for aggregating relevant management functions. The water resources laws of many different countries have changed to reflect this view by: a) organizing national water resources administrations along basin lines; and b) consolidating the allocation and pollution control functions of these administrations. Water users are also represented in basin institutions alongside government representatives, either in an advisory or also in a decision making capacity, to enhance transparency and ensure greater stakeholder ownership and support.

Moreover, rights to abstract and use water, and to discharge waste, are best administered and managed in a basin context. Doing so not only captures the potential of the hydrologic cycle, but also minimizes the chances of conflict across multiple administrative boundaries. In particular, adapting water rights to varying hydrologic and hydro-geologic patterns, to technological advances, and to shifting economic, social and environmental policies, is critical to sustaining water use and to conserving and protecting water resources and water-dependent ecosystems. Experience shows that such adaptation is best done in systems of government-administered rights of abstraction and use, and of wastewater disposal. Such systems hold the best promise for fairly and transparently balancing the security of title sought by investors with the physical uncertainty of water availability and changing public policies.

These are the fundamentals of contemporary water resources legislation from across the world. There is no compelling reason why Asia and the Pacific should be an exception to global trends.

Water Resources Management from a River Basin Perspective

Sukontha Aekaraj
Director
Foreign Relations and International Cooperation Division
Department of Water Resources
Thailand

TO MANAGE WATER resources in a river basin, it is not enough to formulate an overall plan through a limited, technical process using data from previous studies. While many businesses as usual are practiced for example investment in water projects big and small here and there, one might consider implementing a parallel action to

become an alternative to such traditional manner.

For a river basin in a monsoon region, water resources management should clearly recognize time and space perspectives, as well as knowledge of the local people. Different areas in the river basin face different challenges in water resources. Different sets of solutions may be needed to address these challenges. Seasonal variations contribute to the ever-changing challenges. Local people know best the problems but usually do not know how to solve them.

Many problems are very specific and need to be tackled at the local level. But some problems need analyzing and solving at the river basin level, among these is conflicting of water uses in the river basin. Consequently to manage water resources in a river basin context, planning needs to be done in two different types: local and river basin. We need to involve all stakeholders representation in planning, to efficiently manage data and information (including knowledge), and to share these data-information-knowledge between public and people sectors (by this we need government staff who is responsible possesses of multidisciplinary knowledge).

Co-management (between government and people) is defined as an alternative and parallel action to the traditional way of creating water projects. Important factors involving institutional arrangement are: clear responsibility of staff in the RBO, good representation of stakeholders in RBO and also in participation to solve problems both at the local and river basin level, good facilitation in order to promote real and effective participation, and good incentives for RBO staff.

The emerging paradigm would be based on ecosystems perspective and a comprehensive institution for amicable resolution of conflicting claims on water.

River Basin Management: Ideas for Future Direction

BY 2050, MOST river basins in Asia and the Pacific region with large populations will have closed; that is, water use will have exceeded the amount of renewable water available. The agricultural sector will have shrunk everywhere in terms of value and employment, and will have less political clout. Entrenched irrigation agencies will have been forced to disband, large systems will have become multiple-use outfits, and operators of different stripes will have come to dominate service delivery. The water economies will have formalized to a large extent, making the water sector more amenable to regulation by economic, technical and legal instruments. These changes will have been facilitated by the diffusion of measurement and communication technologies that allow for better control and, in the agricultural sector, a quicker move to precision agriculture.

The worsening effects of climate change, basin closure and the inability of water organizations and lower levels of governments to solve their problems will have forced ineffectual water organizations and decentralized authorities to surrender to central authorities under political pressure and implement mega-adaptation measures. Local landscape management organizations, however, may have proved more effective and robust. Everywhere, scientific tools of modeling, supported by diffuse data collection on land and water use, and surface and groundwater hydrology, will have helped to improve understanding and decision making. Ecosystem services and their maintenance will, to a large extent, be engineered. Conjunctive management of surface and groundwater resources will be a reality. Inter-basin linkages will be diffuse. Water and land use for strategic food production objectives (grains) may be set aside and guaranteed by legal instruments.

On the one hand, river basin management can be more demand-driven. It will need to respond to demand for bulk water supply and to the need to solve upstream problems through decentralized or meso-level forms of organizations. Reciprocally, it will need to clearly signal resource constraints and specific results to be achieved locally, setting higher-level objectives for these organizations. River basins may not be the main focus of water management, but only one dimension where water solutions are implemented, alongside interventions in other sectors. In any case, integration of land use, conjunctive management and water quality management are part of the future of river basin management.

What seems to have worked on the ground, in informal water economies such as in India, are social movements for groundwater recharge, water harvesting and groundwater demand management. In formal economies, success has been found by smart urban water utilities in Singapore, and by the application of sound water-accounting principles and incentives for water saving by formal operators in the PRC. What also seems to have worked are lateral solutions by state governments, for example restructuring of rural electricity grids and rationing to control water. Pragmatic approaches to legal instruments have also proved effective.

Looking ahead, we will need to:

- Prioritize improvements in agricultural water productivity and control of agricultural pollution through effective result-based interventions.
- Increase understanding of river basins based on integration of land and water use, sound water accounting, management of both surface and groundwater and water quality, and understanding of the key drivers of change.

Thierry Facon

Senior Water Management Officer
Food and Agriculture Organisation of the United Nations (FAO)

- Adopt a more pragmatic and adaptive management approach. We should not call for political will to implement classical water solutions. Instead, we should call for the will to solve specific water problems requiring political interventions, and work on solutions that are politically palatable or demonstrate the potential of inter-sectoral cooperation.
- Base policies and institutional solutions on the specific details of the problems at hand. Build on successes in solving key problems to show usefulness and relevance as a pathway to institutional growth.
- Give a high priority to and focus energies on solving land, water and ecosystem problems locally through distributed or decentralized governance and management principles.
- Focus capacity building on existing operators and users, rather than try to create new institutional mechanisms. Do not expect miracles from classical instruments – prioritize pragmatic Plan B or second-best solutions.
- Change benchmarking or monitoring and evaluation systems from monitoring processes (creation of an institution, drafting a law, issuing a policy statement) to monitoring their results.

Some Thoughts on Promoting Financial Sustainability for River Basin Management

Tjoek Walujo Subijanto
President Director
Jasa Tirta I Public Corporation
(PJT I)

TO PROMOTE FINANCIAL sustainability for water resources management in river basins, political will and commitment, and engagement by RBOs, are indispensable.

At the policy level, appropriate laws and policies are needed to create sustainable financing mechanisms. This regulatory framework should:

- Ensure that funding for water resources management is based on the principle of cost recovery, including costs of management, returns on capital and construction investments, and reserves for future development.
- Ensure that government contributes to financing water resources management, especially social services (such as irrigation) and people's welfare and safety (flood control, water quality management, and so on).
- Ensure that those who benefit from water resources management also contribute to its costs.
- Support public-private partnerships to strengthen water resources development and management.

Water infrastructure is rightly at the core of global, national and basin-wide dialogues on strategies and priorities for water management.

The role of RBOs as managers of basin water resources is critical to achieving financial sustainability. They should have the powers and capacity to create an enabling environment for implementing the regulatory framework for water financing. They should also be able to develop other sources of funding by optimizing the use of their resources and assets.

RBOs should make stakeholder satisfaction their first concern. If water users are satisfied with the services provided by RBOs, their willingness to pay for these services will increase, contributing to financial sustainability. As part of their commitment to providing a high quality of service and ensuring stakeholder satisfaction, RBOs should institute quality management systems to support their day-to-day activities. They should also meet minimum standards of accountability and transparency.

To avoid dependency, RBOs should not rely on a single source of funding. They should be free to generate revenues from the full range of non-water goods and services obtainable through the wise use of their resources and assets.

In Indonesia, the 2004 Law on Water Resources and the 2008 Regulation on Water Resources Management provide a framework for financing river basin management. They give the PJT I, as a corporate RBO for the Brantas and Bengawan Solo basins, the right to use the revenues from the service fee paid by basin water users to support water resources management.

PJT I considers that accountability and transparency are crucial to winning the trust of stakeholders. Its accounting standards conform to the national accounting standards, and all of its corporate activities are regulated and overseen by the Ministries of Public Works, State-Owned Enterprises, and Finance.

In this supportive environment, the revenue of PJT I from water service fees has grown rapidly from IDR 2.65 billion in 1991 to IDR 182.56 billion in 2010, or almost 70-fold in 20 years. To add to this income, PJT I also generates revenue from non-bulk-water services, including tourism, construction and equipment rental, consulting, water quality testing, agroforestry, drinking water supply, micro-hydroelectric power generation, agribusiness and training.

STATEMENT

Investing in Asia's river basins will increase water security

Wouter Lincklaen Arriens and Ian Makin

Asian Development Bank

IN OUR WORK at ADB, we are privileged to see how water leaders across Asia are taking action to better manage river basins to increase water security. ADB, though its Water for All policy, is committed to fostering IWRM in river basins. *WaterWealth?* shows a sample of how initiatives at the local level are contributing to improving conditions in Asia's basins.

More people than ever before are now aware of the need to conserve water, to increase its productivity, and to maintain the ecosystem services on which societies depend for their prosperity and sustainability. In that sense, we see the glass as already 'half full' when it comes to Asia's desire to invest in basin management now, at a time of greater uncertainties and more extreme weather events. Over the past decade, practitioners and stakeholders have also realized that there are no one size fits all solutions. Rather, the challenge is to find the keys for success to unlock the potential for success in each location.

Meanwhile, peer-to-peer learning among basin managers is increasing and has received a further boost after guidelines for IWRM at the river basin level were launched in 2009 by UNESCO and NARBO, supported by the Japan Water Agency and ADB. With these 'back to basics' guidelines, Asian practitioners working with NARBO, ADB and other partners, are now rediscovering IWRM as an upward spiral of improvements towards achieving the basin stakeholder's shared vision. The IWRM process encourages stakeholders to follow basin road maps that drive incremental performance improvements with each turn, while continuing to adapt to changing conditions along the way.

This approach is refreshing because it helps all stakeholders contribute to generating solutions even where the enabling policies and laws are not well developed, which is still a challenge across much of developing Asia. The spiral also allows stakeholders to recognize improvements and lessons learned in past years and generations.

Moving up the spiral towards improved water security, we see that increasing investments in three areas are certain keys for success with broad application in Asia's river basins. The first is improved measurement of performance and progress to increase water security. The second is combining knowledge from science as well as local information to manage risk and uncertainty. And the third is reversing the alarming deterioration of the quality of surface and groundwater resources in the region.

With its Water Financing Program 2011-2020 and its new Water Operational Plan, ADB is committed to help its clients accelerate the IWRM process in river basins by embedding IWRM into projects.

Preparing Asia's River Basins for the Future

Keizrul Bin Abdullah
NARBO Chair

MANY OF THE successful practices in this valuable *WaterWealth?* book have benefited from knowledge sharing through NARBO. NARBO is Asia's knowledge and innovation network to increase water security in the region's river basins through the process of IWRM especially at the river basin level. The network was established in 2004 as one outcome of the 3rd World Water Forum in Japan.

Drawing on the rich experience of NARBO's 76 member organizations in 16 countries, governments and basin stakeholders are now using the network to help introduce the IWRM process in river basins, and to strengthen the capacity and effectiveness of RBO in promoting IWRM and improving water governance.

NARBO members include RBOs, government agencies, and knowledge partners. The members are supported by an international management team of experienced water leaders, and a strong secretariat comprising the Japan Water Agency, ADB, the ADB Institute, and CRBOM serving as the regional knowledge hub. We work together to demonstrate that win-win solutions can simultaneously increase the economic, social and environmental wealth in river basins, and that these solutions are in fact essential for preparing Asia's river basins for the future.

Behind each story in this *WaterWealth?* book, there are one or more champions who made it possible. In NARBO, we recognize the importance of good leadership and the value of dialogue and knowledge sharing. Leadership helps to create a shared vision among basin stakeholders for a water secure future, to map out a roadmap to achieve the vision, and to span the barriers that prevent stakeholders from working together to implement it.

In addition to benefiting from case-based international training programs in IWRM, NARBO members work together in national chapters, establish twinning partnerships between basins organizations, share experience and approaches to climate change adaptation, and participate in the innovative RBO performance benchmarking service that features both self assessment and peer review. Members lead the pursuit of water security in the context of the food-water-energy-climate change nexus; and also learn how to work effectively with politicians and planning and finance agencies to advance IWRM. NARBO is supporting the pilot programs for certification of IWRM leaders in basins and basin organizations across Asia.

IUCN and ADB are both active NARBO members, and I congratulate them for their leadership to produce this valuable book of good practices that are already increasing water wealth in some of Asia's river basins.

Investing in Natural Infrastructure for More Sustainable River Basin Development

Dr Mark Smith
Director
IUCN
Global Water Programme

RIVER BASIN ORGANIZATIONS must confront an agenda for water resources management that can be dauntingly complex. Their challenge is to ensure water is available in the quantities and quality needed to grow the economy, feed a rapidly growing population and deliver water services for all. They must do all this while ensuring social equity – especially for women and children, poor people and the vulnerable – and sustaining and restoring ecosystems. Transboundary RBOs must attempt this while balancing the multiple and often competing interests of countries sharing water resources. As we look ahead, the challenge gets no easier. Water managers will be at the forefront of climate change adaptation, and of the development and deployment of technologies needed to build and sustain the energy systems and cities of the future.

The goal for water resources management globally must be no less than water, food and energy security for nine billion people in a climate-resilient world where biodiversity is safeguarded.

Water infrastructure is rightly at the core of global, national and basin-wide dialogues on strategies and priorities for water management. Dams, reservoirs, irrigation and flood barriers are often prioritized as options for meeting future water resource challenges. In envisioning the river basins of the future, however, one critical component of infrastructure is widely overlooked. This is natural infrastructure.

Just as built infrastructure stores, moves, regulates and cleans water, so does nature. Watersheds – and their soils, watercourses, wetlands, aquifers and floodplains – are natural infrastructure. Managing water-related risks is harder where slopes are eroded, wetlands drained, and floodplains degraded and disconnected from rivers. The degradation of natural infrastructure in watersheds reduces the benefits of ecosystem services for development. Benefits from healthy watershed ecosystems include a reliable and clean water supply, protein from fisheries, and productive agriculture. Losing natural infrastructure can weaken resilience and hinder economic development.

Recognizing the role and value of natural infrastructure will not diminish the role of RBOs in national and regional economic development. Instead, working with natural infrastructure will provide new tools and options for making river basin development more equitable and sustainable. Using natural infrastructure does not replace the need for built infrastructure. Instead, it may provide more cost-effective options, for example when the benefits of healthy ecosystems exceed those of engineered options. Natural infrastructure will always complement built infrastructure. For example, dams benefit from forests that stabilize soils and hold back erosion upstream. Lakes and wetlands provide water storage, reducing the reservoir volume needed and the cost of built water storage. The multiple ecosystem services provided by natural infrastructure multiply the benefits received. In this sense, well-functioning natural infrastructure is necessary if built infrastructure is to perform more effectively, deliver its projected benefits and increase its returns on investment.

Thinking in terms of natural infrastructure provides RBOs with an opportunity to break away from old-fashioned, polarized thinking, in which nature is something to be fixed or fought over once the needs for built infrastructure have been taken care of, or a luxury for those who can afford it. Infrastructure can instead be planned and managed with built and natural components, and just as built infrastructure needs investment, so does the upkeep and restoration of natural infrastructure. Investment in water infrastructure in the river basins of the future will need to be made through portfolios that integrate built and natural components.

Both built and natural infrastructure are needed to meet the multiple and complex goals of river basin management. To implement the necessary investment strategies, RBOs will need new analytical tools and capacities, and increasingly they will have to play the role of a broker in new partnerships between multiple stakeholders. Ultimately, such shifts in strategies, plans and operations will be required for RBOs to meet the expectations placed on them in a complex and rapidly changing world.

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GLOSSARY

Aquifer: An aquifer is a wet underground layer of water-bearing permeable rock or gravel, sand, or silt from which groundwater can be extracted using a pump.

Basin: A basin is the area drained by a river and its tributaries, and is considered the basic unit of water management.

Biochemical oxygen demand (BOD): BOD is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.

Biomass: Biomass, a renewable energy source, is biological material from living, or recently living organisms such as wood, waste, gas, and alcohol fuels. Biomass is commonly plant matter grown to generate energy.

Blue water: Blue water is the water that flows rapidly through rivers, lakes, aquifer, and seas.

Catchment: A catchment is an extent or an area of land where surface water from rain and melting snow or ice converges to a single point, usually the exit of the basin, where the waters join another waterbody, such as a river, lake, reservoir, estuary, wetland, sea, or ocean.

Contiguous irrigation system: A continuous chain of long irrigation structures with a huge geographical spread

Conveyance efficiency: Ratio of the volume of irrigation water delivered by a distribution system to the water introduced into the system.

Critically endangered: Critically endangered means that a wild species numbers have decreased, or will decrease, by 80% within three generations.

Crop water budgeting: It is a process of calculating the amount of water required for irrigation in a particular land area and then budget the available water accordingly.

Disability-adjusted life year (DALY): DALY is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.

Distributaries: A distributary, or a distributary channel, is a stream that branches off and flows away from a main stream channel which are a common feature of river deltas.

Ecologically critical area: Ecologically critical area are ecologically defined areas or ecosystems affected adversely by the changes brought through human activities.

Ecologically dead: Ecologically dead is the state of a water body that lacks any living organisms.

Environmental flows: Environmental flows refer to the amount of water needed in a watercourse to maintain healthy ecosystems and ensure livelihood.

Environmental user fee system: The environmental user fee system charges a polluter a fee based on the amount of pollution that is discharged into waterbodies within a basin area.

Evapotranspiration: Evapotranspiration is a term used to describe the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere.

Forest corridor: A corridor created within a forest area to allow wild life movement between different forest islands.

Gadhera: A *gadhera* is a small stream of water flowing downwards from top of the hill.

Geomembranes: Geomembranes are a kind of geosynthetic material which are impermeable membranes used widely as cut-offs and liners mostly as canal and pond liners.

Green water: Green water is the amount of water stored in the soil pores which can be consumed by the plants.

Gully conservation: Measures taken to conserve gullies, which are deep ditch or channel cut in the earth by running water after a prolonged downpour.

Headwaters: Headwaters of a river or stream is the place from which the water in the river or stream originates.

Impermeable membranes: Impermeable membrane is a membrane that does not allow molecules or ions to pass through.

Infiltration: Infiltration is the process by which water on the ground surface enters the soil.

Irrigation efficiency: Irrigation efficiency involves proper designing, installation and maintenance of irrigation systems to ensure uniform and efficient distribution of water, thereby conserving water and protecting water resources.

Integrated water resources management (IWRM): IWRM is a systematic process for the sustainable development, allocation, and monitoring of water resource use in the context of social, economic, and environmental objectives.

Karez/Qanat: A *karez/qanat* is a traditional water management system used to provide a reliable supply of water for human settlements and irrigation in hot, arid, and semi-arid climates.

Multipurpose retarding basin: A basin designed and operated to provide temporary storage and thus reduce the peak flood flows of a stream.

Multitranche finance facility: A long-term investment programme for developing infrastructure which provides financing that can be converted into smaller packages to fit specific project components.

Natural infrastructure: Watersheds, and their soils, watercourses, wetlands, aquifers, and floodplains — are natural infrastructure.

Nitrogen loads: Nitrogen load refers to the total amount of nitrogen entering the water during a given time, such as "tons of nitrogen per year."

***Orang Sungai*:** *Orang Sungai*, which means “River People” in Malay, are a group of indigenous people native to the state of Sabah, Malaysia.

Participatory irrigation management: Management of irrigation infrastructure with participation from various stakeholders including farmers.

Payment for ecosystem services (PES): PES, broadly defined, is the practice of offering incentives to farmers or landowners in exchange for managing their land to provide some sort of ecological service.

Ramsar site: Wetlands are designated as Ramsar site based on the convention on wetlands which was signed in Ramsar, Iran.

Riparian: A riparian zone is the interface between land and a river or stream.

River basin organization (RBO): RBOs are established with the involvement of various stakeholders with the aim to empower stakeholders to play a full part in decision-making and management for basin water resources.

Self help group (SHG): An SHG is a village-based financial intermediary usually composed of between 10-20 local women.

Siltation: Siltation is the pollution of water by fine particulate terrestrial material, with a particle size dominated by silt or clay and is most often caused by soil erosion or sediment spill.

Soums: In Mongolia, provinces are subdivided into *soums* (or *sooms* or *sums*), translated as sub-provinces, districts, or counties.

Sub-basins: A portion of a sub-region or basin drained by a single stream or group of minor streams.

Tertiary treatment: Tertiary treatment is the next wastewater treatment process after secondary treatment. This step removes stubborn contaminants that secondary treatment was not able to clean up.

Transboundary river: A transboundary river is a river that crosses at least one political border, either a border within a nation or an international boundary.

Virtual water: Virtual water refers, in the context of trade, to the water used in the production of a good or service.

Water budget: A water budget reflects the relationship between input and output of water through a region.

Water harvesting dams: Mini dams built to harvest the rainwater runoff.

Water stress: Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use.

Water user association (WUA): A WUA is a cooperative association of individual water users who wish to undertake water-related activities for their mutual benefit.

Water user fee: A fee which is collected only from those persons who use a particular service, as opposed to one collected from the public in general. User fees generally vary in proportion to the degree of use of the service.

Wetlands: A wetland is an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be covered partially or completely by shallow pools of water.









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Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila
Philippines

Tel +63 2 632 4444
Fax +63 2 636 2444
www.adb.org

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IUCN Asia Regional Office
63 Sukhumvit Road Soi 39
Wattana, Bangkok 10110
Thailand

Tel +662 662 4029
Fax +662 662 4387
www.iucn.org/asia

The Network of Asian River Basin Organizations (NARBO) was established in February 2004 to help achieve integrated water resources management (IWRM) in river basins throughout Asia. Its objective is to strengthen the capacity and effectiveness of RBOs in promoting IWRM and improving water governance through training and exchange of information and experiences among RBOs and their associated water sector agencies and knowledge partner organizations. There are 76 member organizations from river basin organizations, national and local government organizations, regional and inter-regional knowledge partners, and development cooperation agencies. Membership is open to organizations which implement or promote IWRM.

Network of Asian River Basin Organizations
c/o Japan Water Agency
11-2 Shintoshin, Chuo-ku
Saitama City
Saitama Prefecture 3306008
Japan

Tel +81 48 600 6553
Fax +81 48 600 6509
www.narbo.jp

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Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila
Philippines

Tel +63 2 632 4444
Fax +63 2 636 2444
www.adb.org

IUCN Asia Regional Office
63 Sukhumvit Road Soi 39
Wattana, Bangkok 10110
Thailand

Tel +662 662 4029
Fax +662 662 4387
www.iucn.org/asia