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**BUILDING CAPACITY TO MONITOR WATER QUALITY:  
A FIRST STEP TO CLEANER WATER IN DEVELOPING COUNTRIES**

**OECD Trade and Environment Working Paper No. 2006-03**

**by Jim Hight and Grant Ferrier  
Environmental Business International**

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## ABSTRACT

One of the key challenges to ensuring adequate supplies of fresh water and sanitary wastewater systems is to build the capacity of various stakeholders to manage and deliver water and sanitation services. One element of such capacity building is technological and includes the wide deployment of water quality monitoring and analysis equipment. This report explores four cases, in China, India, Malaysia, and Chinese Taipei, where the water-quality monitoring and protection capacity has been improved through the use of imported water-quality monitoring equipment combined with indigenous implementation.

*Key words: water quality, environmental goods, developing countries, trade, China, India, Malaysia, Chinese Taipei*

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**BUILDING CAPACITY TO MONITOR WATER QUALITY:  
A FIRST STEP TO CLEANER WATER IN DEVELOPING COUNTRIES**

Despite some progress over the last 15 years, inadequate fresh water supplies and the lack of sanitary wastewater systems plague vast regions and populations of the planet. The grim statistics were highlighted most recently at the Fourth World Water Forum in Mexico City. Approximately 1.1 billion people lack consistent access to clean drinking water, while 2.6 billion people suffer from inadequate sanitation. As a result, diarrhea diseases associated with tainted water and inadequate sanitation kill 1.8 million people annually, mostly children.<sup>1</sup>

In Asia alone, more than 650 million people did not have access to safe drinking water in 2002, according to Asia Water Watch 2015, a report commissioned by the Asian Development Bank to measure progress toward the water quality components of the Millennium Development Goals (MDGs), which aim to reduce by half the number of people lacking adequate water and sanitation.<sup>2</sup>

As underscored in statements issued at the Fourth World Water Forum, building the capacity of communities, local, regional and national governments, NGOs and firms to manage and deliver water and sanitation services are key challenges in meeting the MDGs for water. “Capacity development is a cornerstone for sustainable development, hence directly related to the real chances to achieve the Millennium Development Goals and reduce extreme poverty,” states the World Water Council in its report on the forum.<sup>3</sup>

While capacity building encompasses financial, educational and social goals, there is also a technological element, in which water quality monitoring and analysis equipment must be deployed on an increasingly wide scale in developing countries where water supply and wastewater treatment is inadequate.

#### **FOUR CASE STUDIES**

##### ***Joint ventures and collaborations build capacity to monitor and improve water quality***

This paper explores four case studies in which the water-quality monitoring and protection capacity in developing countries has been improved through the use of imported water-quality monitoring equipment combined with indigenous implementation. The cases studied include a mixture of freshwater supply and wastewater treatment programmes, including a joint venture between a Chinese state government entity and a private U.S. firm; a joint venture between a Malaysian firm and a Canadian firm; a technology

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<sup>1</sup> World Water Council (2006) Facts and Figures. Available at: [www.worldwatercouncil.org/index.php?id=25](http://www.worldwatercouncil.org/index.php?id=25)

<sup>2</sup> Seetharam, Kallidaikurichi Easwaran, James Bartram, Anuradha Rajivan and Nanda Kraikiksh (2006) Asia Water Watch 2015, Asian Development Bank, United Nations Development Programme, United Nations Economic and Social Commission for Asia and the Pacific and World Health Organization. Available at: [www.adb.org/Documents/Books/Asia-Water-Watch/default.asp](http://www.adb.org/Documents/Books/Asia-Water-Watch/default.asp)

<sup>3</sup> Fourth World Water Forum (2006) Ministerial Declaration. Available at: [www.worldwatercouncil.org/index.php?id=30](http://www.worldwatercouncil.org/index.php?id=30)

demonstration project for a college in India funded by the U.S. Council of State Governments; and a project in Chinese Taipei in which a domestic equipment dealer has leveraged technology from a U.S. firm to develop new remote-monitoring capabilities for the country's national electric utility.

In all the cases, imported water-quality monitoring and analysis equipment were used because the sophisticated capabilities required by projects were not available from indigenous manufacturers. But increasingly, manufacturing of such equipment is being done in China and other countries, either under license from developed-world manufacturers or with proprietary design and engineering. Hach Environmental, the U.S. equipment supplier highlighted in the Chinese Taipei case, is manufacturing some of its branded water-quality monitoring instruments in China. A company spokesman reports that the arrangement is part of cost-driven outsourcing as well as an effort to serve the growing Chinese market for water-quality monitoring equipment. This trend will likely continue as demand for these instruments in developing countries increases.

It seems clear, however, that there is already a significant capacity building component in projects such as these that use analytical technology imported from developed nations. Domestic project managers and staff are trained in calibrating, operating and maintaining the equipment, developing important expertise. And in the Chinese Taipei case, the domestic firm has added significant value to the imported equipment. In that case, USD 30,000 worth of imported equipment was leveraged to generate more than USD 100,000 in value.

It should also be noted that these types of environmental monitoring projects improve the capacity of regulatory bodies to identify sources of pollution and respond effectively. They also contribute to non-institutional capacity building in a country's NGO community and its citizenry, empowering them with knowledge about the causes of water pollution and providing leverage to seek improvements from regional or national governments, as well as funding from multilateral funding agencies.

## **Tianjin, China**

### ***Renovation of Jie Yuan water treatment plant***

Within the last decade China has dramatically improved its water and wastewater infrastructure and refined its 1988 national water quality law to value water resources appropriately and create market mechanisms for capital investment in water and wastewater systems. But with the country's extraordinary rates of economic and population growth, coupled with accelerated urbanization, China's water-quality challenge is growing.<sup>4</sup>

One particular concern for water quality in China is the increasing algae loads in rivers that are used to supply residential and commercial water users. Effluent from industrial sources stimulates algae growth, which also fluctuates with weather and rainfall amounts. Rivers that are heavily used for agriculture and industry become more susceptible to algae problems. When flows are reduced by agricultural diversions and drought—as has occurred in recent years—water temperatures rise and algae loads increase to the point where they can render water supplies toxic. Chinese provincial authorities are pursuing enforcement actions against industrial dischargers that are exceeding prescribed limits, in many cases forcing them to shut down during dry months. But technological solutions are also needed.<sup>5</sup>

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<sup>4</sup> U.S. Department of Commerce, International Trade Administration (2005) Water Supply and Wastewater Treatment Market in China. Available at: [www.ita.doc.gov](http://www.ita.doc.gov)

<sup>5</sup> China Daily (2004) Toxic Algae Poses Environment Problem. November 25, 2004. Available at: <http://www.china.org.cn>

In the fast-growing city of Tianjin, the municipal water authority Tianjin Water Works (TJW) has been plagued by high algae levels in the Luan and Yellow rivers during summers in particular. In 2000, the water authority began planning an upgrade to its Jie Yuan Water Treatment Plant. The plant, which supplies water to 3 million people, was failing to meet water-quality standards because of the high algae loads in the river sources. After a research effort, TJW chose a dissolved air flotation (DAF) system designed by Earth Tech (Long Beach, Calif., USA) because of its effectiveness in handling high algae levels.

Earth Tech and TJW entered a 20-year joint venture to design, build and operate the water-treatment plant. The project involves replacing part of the existing plant with new DAF technology, and improving the operation of the balance of the plant with imported monitoring instruments. Capital investment (amount not disclosed) was provided by the joint venture parties, and it is anticipated that capital costs, operating expenses and return on investment for private capital will be achieved through revenues from water sales. Earth Tech owns 52 percent of the joint venture, TJW owns 48 percent.

The new DAF system is nearly complete as this document was being finalized. Upon completion, the Jie Yuan Water Treatment Plant will be one of the largest DAF facilities in the world, producing approximately 500 million liters per day. The balance of the plant has continued to operate, but with imported monitoring instruments deployed by the joint venture to improve efficiency. Specifically, online monitoring instruments have allowed operators to reduce turbidity by 50 percent and to reduce the use of chemicals (including ammonia and chlorine) by 30 percent. Incorporation of monitoring instruments has also allowed TJW operators to meet the increasingly stringent standards for turbidity. In addition, flow meters installed as part of the project are allowing operators to conserve about 10 million liters per day of water that was previously discharged. The new monitoring equipment also alerts staff to needs for preventative maintenance, reducing the occurrence of breakdowns. And with timely access to online operational data, plant operators can fine tune their operation promptly, analyzing and diagnosing problems for continuous performance improvement.

Managers and staff at the Jie Yuan Water Treatment Plant (now employees of the joint venture) have been trained by Earth Tech staff to operate the DAF system—including field training in Canada, Australia and other countries where DAF systems are in use—and the online monitoring instruments. By terms of the joint venture agreement, Earth Tech will support local managers and staff with continuing operations and maintenance training.

Managers of the joint venture report that the use of these types of online water monitoring equipment is increasing in many parts of China, but that poorer cities and rural areas still lack such sophisticated devices. They also report that it is becoming increasingly common for Chinese manufacturers to produce such equipment, either under license or through joint ventures with manufacturers from developed countries.

### ***Imports of goods associated with the project***

Import tariffs were not a significant cost, as they have been reduced progressively since China entered the World Trade Organization.

- Pressure gauges (HS 9026.20)
- Thermometers and pyrometers (HS 9025.11)
- Instruments for measuring the flow of liquids (HS 9026.10)
- Other instruments (HS 9026.80)
- Gas analysis apparatus (HS 9027.10)

**Jawaharlal Nehru Technological University (JNTU) Kukatpally, greater Hyderabad, Andhra Pradesh, India**

***Construction of wastewater treatment system***

Some of the world's largest rivers flow from the glaciers and snow packs of the Himalayas to supply the needs of India's people, farms and industries, as well as sacred media for religious rituals and spiritual sustenance. But the rapid growth and urbanization of India's population have put tremendous pressure on its rivers and other water resources. One particular concern is the inadequate treatment of sewage, which in its worst manifestations has polluted drinking water supplies and led to serious outbreaks of cholera.<sup>6</sup>

As in many developing countries, capital for infrastructure is quite constrained, so government entities must seek low-cost approaches for sewage treatment plants, such as constructed wetlands and biological treatment systems. A pilot project in greater Hyderabad, Andhra Pradesh, may offer a model for effective, low-cost sewage treatment systems.

With its population growing by approximately 17% annually, Hyderabad is projected to increase its numbers of residents from more than 6 million to at least 9 million by 2011. The Musi River that flows through Hyderabad is already subject to excessive input of untreated sewage, and without new treatment systems, this pollution will only increase.<sup>7</sup> To test new sewage treatment technology, the Jawaharlal Nehru Technological University (JNTU) campus in Kukatpally, greater Hyderabad, collaborated with the U.S. Council of State Governments, Maryland Technology Development Corporation and S&M Engineering (Crofton, Maryland, USA) to construct a wastewater treatment system using biological treatment technology developed by S&M.

The anaerobic "deep pond" system incorporates a primary digestion chamber (64 x 64 feet wide and 17 feet deep) to degrade sewage sludge and solids from the wastewater generated by the campus's approximately 2,000 resident students and staff. Raw sewage flows directly into the deep pond, then goes through an aeration pond and a solarization pond. Completed in August 2004, the project was fine tuned for several weeks, and began to function successfully within a month. The treated effluent is being used to irrigate JTNU orchards.

Funding for the USD 80,000 project was provided by U.S. Council of State Governments and by S&M Engineering, which seeks to patent the deep pond technology and leverage its success at JTNU in Hyderabad to develop similar systems elsewhere in India.

Portable water-quality monitoring kits were used at the site to measure dissolved oxygen, nitrates, phosphorus and other vital parameters for water quality. Ongoing monitoring is conducted by S&M staff based in India, with some support from JTNU staff.

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<sup>6</sup> Kumar, Vipin (2002) Water Pollution of Yamuna. NISTAD News, Vol. 4, No. 2, October 2002. National Institute of Scientific, Technical and Development Studies. Available at: <http://nistads.res.in/ppl/vipan/yamnua.pdf>

<sup>7</sup> International Water Management Institute, Resource Centres on Urban Agriculture and Food Security (2004) Urban and Peri-Urban Agriculture in Hyderabad. Available at: [www.ruaf.org](http://www.ruaf.org)

***Imports of goods associated with the project***

Materials to build the deep pond treatment system were acquired within India. The monitoring instruments were manufactured in the United States and their cost-- as well as associated import tariffs-- were an insignificant part of the project's costs.

- Portable conductivity meters (HS 9026.80)

**Malaysia*****Nationwide water quality monitoring network***

In the early 1990s, the Malaysian government issued a bold request for proposals to build a nationwide air-quality monitoring system, one for which the successful bidder would provide its own financing in exchange for a long-term contract to sell air quality data to the government. The successful contractor was Alam Sekitar Malaysia Sdn. Bhd (ASMA), a joint venture incorporated in 1993 by the Malaysian PIC Group and Bovar, a Canadian environmental services company. (Bovar later merged with Orbus Life Sciences, a pharmaceutical company.)

After building and operating a nationwide network of air-quality monitoring stations (that used imported equipment) in the early 1990s, ASMA expanded its mission to include water quality monitoring and other environmental services. In 1999 it received a 20-year contract to provide river quality monitoring for the Malaysian Department of Environment (DOE) for a fee of approximately USD 3.3 million annually. The system includes 15 continuous water quality monitoring stations on rivers that are important water sources in Malaysia, with plans for an additional 10 stations to be built over the next three years. The system is linked in an electronic data network to ASMA and DOE allowing real-time monitoring and responses to pollution events, such as unlawful discharges from industrial facilities. It also includes more than 1,000 portable manual water quality monitoring stations where samples are taken periodically by staff and analyzed in laboratories.<sup>8</sup>

Each of the 15 continuous water quality monitoring stations is equipped with multiparameter monitoring instruments manufactured by YSI Inc. (Yellow Springs, Ohio, USA). The equipment cost was approximately USD 250,000, which was financed by ASMA. ASMA data has been used to identify high levels of pollutants, in particular ammonia from agricultural operations and industries. In part as a result of these findings, additional water treatment ponds have been constructed in critical areas.

While the equipment is imported from the United States, it was sold through a Malaysian dealer, which also provides service, including training updates to ASMA staff four times a year.

Water treatment and distribution systems are being increasingly privatized by Malaysia's national government and its 13 states. This process is subject to intense debate, with proponents pointing to the need for capital investment in infrastructure and opponents expressing fears of sharp water tariff increases. ASMA's monitoring system will likely be unaffected, continuing to provide prompt and objective information about the state of Malaysia's water resources, regardless of whether the entities drawing on those resources are private or public.

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<sup>8</sup> Alam Sekitar Malaysia Sdn. Bhd. (ASMA) website (2006) About Us. Available at: [www.asma.com.my/MainWeb/env-info.htm](http://www.asma.com.my/MainWeb/env-info.htm)

### ***Imports of goods associated with the project***

Import tariffs on the water-quality monitoring equipment were approximately 10%, plus an additional 5% for value-added tax.

- Multiparameter water-quality monitoring instruments (HS 9026.80)

### **Sung-Mau and Yu-Sang Rivers**

#### ***Chinese Taipei***

Water pollution in Chinese Taipei varies dramatically based on regional differences in rainfall and the proximity and density of effluent sources such as industries, agriculture and population centers. Groundwater resources are particularly impacted by overuse in the Chinese Taipei basin, with high electrical conductivity measurements indicating intrusion of salt water. Groundwater issues make Chinese Taipei's rivers and reservoirs all the more critical for adequate supply of water for residents, industries and agriculture.<sup>9</sup> More than 250 water-quality sampling stations have been established on the country's rivers. To make water-quality monitoring more effective on the important Der-Chi Reservoir, the national Taiwan Power Company (TPC) built in 2005 three new automated monitoring stations on the Sung-Mau and Yu-Sang rivers which feed the reservoir.

The installation allows TPC to access real-time water quality data without assigning staff to make site visits to collect samples and bring them to a laboratory for analysis. This allows for more consistent monitoring and more rapid responses to changes detected in water quality. It can also provide operators of the water treatment system on Der-Chi reservoir timely information on any changes in the source water composition.

The system integrates Hydrolab multiparameter water-quality monitoring devices manufactured by Hach Environmental (Loveland, Colorado, USA) with Hach Environmental software modified by Chinese Taipei-based Panwell Technology Company. Panwell enabled the software to translate data and commands into Chinese, and enhanced the existing data conversion capabilities to provide more targeted information for TPC's remote operators. Panwell trained TPC operators in operating the remote monitoring system, and the Chinese Taipei company provides ongoing service. The imported equipment used in the system cost approximately USD 30,000, while the entire project, including peripheral components, construction and network integration, exceeded USD 100,000.

This project demonstrates a positive leveraging of environmental equipment from the developing world with indigenous expertise and marketing. With an exclusive arrangement with Hach Environmental, Panwell is pursuing other clients for the remote automated water-quality monitoring system it jointly developed.

### ***Imports of goods associated with the project***

Because of the low cost of the imported equipment (USD 30,000), import tariffs were not a significant issue in project design.

- Multiparameter water-quality monitoring instruments (HS 9026.80)

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<sup>9</sup> Academia Sinica (2004) Surface Water Resources of Taiwan. Available at: [www.sinica.edu.tw/~iuggwww/IAHS/iahs/intro/1.htm](http://www.sinica.edu.tw/~iuggwww/IAHS/iahs/intro/1.htm)