

# WATER FIGURES

TURNING  
RESEARCH  
INTO  
DEVELOPMENT

QUARTERLY NEWSLETTER OF THE  
INTERNATIONAL WATER MANAGEMENT INSTITUTE



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## ISSUE 1 2008



## ANNOUNCEMENT

### IWMI – A "Water Knowledge Hub" in the Asia Pacific Region

IWMI has joined the soon-to-be-launched network of "Water Knowledge Hubs" in the Asia Pacific region. An initiative of the ADB together with UNESCO-IHE and PUB Singapore, the hubs, located in different parts of the region will share knowledge in different areas of water management, helping countries cope with future water challenges. IWMI will focus on irrigation performance and reform. Each hub has its own area of specialization. Candidate hubs met in Singapore from the 2-4 April 2008 to finalize their business plans and are expected to begin operations shortly, building up a network of partners and clients in the Asia Pacific region. Water sector and development agencies, training institutes, universities, as well as private and public sector organizations are invited to join as partners or clients of the hubs.

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# EDITORIAL

WATER FIGURES ISSUE 1, 2008




## “Flood Transfusions”

Water, the “blood of the biosphere”, is grabbing the world's attention these days. Against a backdrop of growing water scarcity, it is no wonder that the profile of water is rapidly rising on the development agenda. The Davos discussions early this year gave water the center stage, as participants drew up ambitious action plans for meeting future water challenges. We are pleased to present IWMI's contribution to these critical discussions and to note that the findings of the Comprehensive Assessment of Water Management in Agriculture are finally hitting home with alarming and often inconvenient truths.

While some countries are getting drier by the day, others are plagued by a surplus of water from monsoonal rains, flash floods and other excesses. Can this water be harnessed for future dry spells? We think so. Science is looking at ways and means of harmonizing seasonal surpluses and off-season droughts and harvesting water for times when it is most needed, for people and the environment. In countries where water is shared across political boundaries, disputes are brewing or breaking out between upstream and downstream users over who gets more water. Again, a “transfusion” of life-giving water through improved irrigation systems, equitable distribution and institutional reform, can pull downstream communities out of dire straits.

Wastewater – a health hazard to some – is a source of income to others. Poor farmers in Africa and Asia use nutrient-rich but untreated wastewater flowing out of cities, to grow cash or food crops for a living. In a world where water scarcity threatens, wastewater, if used in a safe and sustainable way, can be seen as a resource for the poor. The Wastewater, Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA) project highlights wastewater work carried out in Sri Lanka and Bangladesh, where dialogues between different sectors are bringing in a better understanding of the issues at hand and paving the way for inter-sectoral cooperation.

This edition of Water Figures demonstrates the power water wields—in global economies and rural communities. In transboundary allocations and urban agriculture. In the simple, mundane realities of living ...water is the stuff of life. What would we do without it? 

Dawn Rodriguez

**Editor**

### EVENTS

#### **International Conference on Integrated Water Resources Management (IWRM): Lessons from Implementation in Developing Countries**

Cape Town, South Africa, 10-12 March 2008

Organized by: Water Research Commission (WRC) (South Africa), UNESCO IHP focal point, Department of Water Affairs and Forestry (DWAF) (South Africa), and Water Institute of Southern Africa (WISA).

**For more information contact:** Ms. Elanda Botes, DWAF, [wbr@dwa.gov.za](mailto:wbr@dwa.gov.za) or Dr. Shafick Adams, WRC, [shaficka@wrc.org.za](mailto:shaficka@wrc.org.za)

#### **33rd WEDC International Conference: Access to Sanitation and Safe Water: Global Partnerships and Local Actions**

Accra, Ghana, 07-11 April 2008

Organized by: Water Engineering Development Centre (WEDC), Loughborough University

**For more information contact:** Mrs. Gill Evans, Conference Administrator, WEDC, UK, [wedc.conf@lboro.ac.uk](mailto:wedc.conf@lboro.ac.uk)

#### **Groundwater and Climate in Africa**

Kampala, Uganda, 25-28 June 2008

Organized by: University of Cambridge and UNESCO International Hydrological Programme (IHP)

**For more information contact:** Conference secretariat, [info@gwclim.org](mailto:info@gwclim.org)

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### AWARDS

IWMI won the 2008 John I. Davidson ASPRS President's Award from the American Society for Photogrammetry and Remote Sensing (ASPRS). Five IWMI researchers (Prasad S. Thenkabil, Parthasarathy Gangadhara Rao, Trent Biggs, Murali Krishna Gumma, and Hugh Turrall) were the second place recipients of the prestigious 2008 John I. Davidson ASPRS President's Award for practical papers by the American Society for Photogrammetry and Remote Sensing (ASPRS).

The award winning paper: Spectral Matching Techniques to Determine Historical Land Use/Land Cover (LULC) and Irrigated Areas using Timeseries AVHRR Pathfinder Datasets in the Krishna River Basin, India.

### Big Win

IWMI Post-doctoral fellow, Aditi Mukherji won the first prize under the Natural Resources: Risks and Implications for Sustaining Development category at the 2007 Global Development Awards and Medals Competition in Brisbane, Australia. Her paper, titled 'The paradox of groundwater scarcity amidst plenty and its implications for food security and poverty alleviation in West Bengal, India: What can be done to ameliorate the crisis?' was one among the five short-listed from over 600 papers submitted in the category. The GDN Awards and Medals Competition was set up with support from the Japanese government and is the largest international contest for research on development.



# Planning for a Watertight Future: IWMI at The Davos Discussions

When the “Powers that Be”, a coalition of international business and industrial leaders, governments and NGOs met at the World Economic Forum in Davos this January, they all agreed that we are on the brink of a global water crisis. As the global population grows and the economies of countries expand, the world is going to get hungrier and thirstier. It takes a lot of water to make the economy tick. Agriculture uses up to 70% of the world’s freshwater. To make basic things for development, like cement, steel, chemicals or power generation takes tons of water. The challenge of climate change adds to the urgency of the moment. Already over 20% of the global population live in areas where the limits of sustainable water use have been reached... or breached.

IWMI contributed to the Davos discussions during a session on “Managing Our Future Water Needs: A Call to Action on Water for Health, Industry, Agriculture and the Environment,” during which the results of the recently concluded Comprehensive Assessment of Water Management in Agriculture (CA), led by IWMI, were tabled.

The argument was that clean and reliable water resources can no longer be taken for granted. The growing competition for water resources between different sectors, coupled with changing allocations and negotiations is creating unhealthy tension between different stakeholders.

The CA’s overarching research question is “Is there enough land, water and human capacity to produce food for a growing population over the next 50 years – or will we run out of water?”

To answer the question, results of the five year CA study show that it is possible to produce the food – but is probable that today’s food production and environmental trends, if continued, will lead to crises in many parts of the world.



Photo Credit Sanjini de Silva

Research shows that over 20% of the global population live in areas where the limits of sustainable water use have been reached... or breached.

The CA’s messages already influence key global research, development and investment initiatives. The research agenda of the Consultative Group on International Agricultural Research (CGIAR) Challenge Program on Water and Food (CPWF) is building on the CA results and will address the key knowledge gaps. The CA is currently informing the agriculture investment strategies and discussions of major organizations such as the Bill and Melinda Gates Foundation and the World Economic Forum (WEF). But there is still a long way to go to change the way people think about water.

At Davos, a call for multi-stakeholder action was led by the Food and Beverage community including corporate giants like Pepsico and Nestlé, to develop an action plan that leverages the strength of the private sector to help address key water challenges.

The CA engaged stakeholders from around the world to establish a common understanding of the issues at hand and achieve consensus on practical, achievable options. Eight timely recommendations for action emerged from the study and were presented at the Davos Forum:

1. Change the way we think about water and agriculture
2. Fight poverty by improving access to agricultural water and its use
3. Manage agriculture to enhance ecosystem services
4. Increase water productivity
5. Upgrade rainfed systems—a little water can go a long way
6. Adapt yesterday’s irrigation to tomorrow’s needs
7. Reform the reform process—targeting state institutions
8. Deal with tradeoffs and make difficult choices



## Needed: An Integrated Approach

Rather than allow water basins that straddle multiple political boundaries to become flashpoints for crisis, it is better to turn them into hubs for water management innovation. Confronted by these challenges, the Davos discussions showed that the private sector has a critical role to bring about part of the solution.

Twenty years ago, water resources management was viewed through trends along the value chain. Structures are more complex today, because we live and work within interconnected river basins and watersheds. By adopting a network approach to water management through partnerships with different stakeholders in a river basin, more opportunities can emerge to manage water much more effectively, often with significant cost savings.

*There are few global markets where water stress will not present considerable challenges for businesses and for wider economic growth. A survey found that 40% of Fortune 1000 companies agree that the impact of a water shortage would be severe, but only 17% are prepared for such a crisis!*

### Hard Facts

# 7 billion people

in 60 countries will be facing water shortages by the middle of the 21st century (UN World Water Development Report).

# 2 billion people

will have suffered from flood damage stemming from population increase and climate change by the middle of the 21st century (UNU-EHS 2004).

# 1.1 billion people

do not have access to proper drinking water facilities such as aqueducts and tubewells (IMF report, UNICEF/WHO 2006).

# 3.8 million people

die each year of water-related diseases (UN World Water Development Report 2nd edition 2006).

# Where Has All the



Photo Credit Saajini de Silva

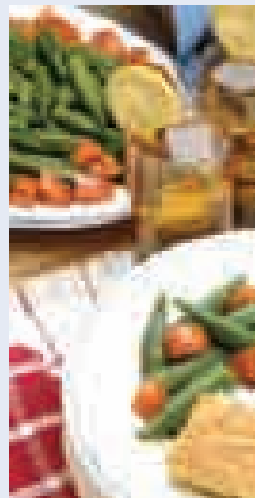
Unlike carbon reduction, there is no water alternative to promote. Nor is there a global solution to negotiate. Turning off your tap in Toronto will not mitigate the drought in India. Water is local, but water issues play out through competing needs in the world's major water basins.



Photo Credit IWMI Southeast Asia

### As the world gets wealthier, it consumes more water

In Asia, wheat consumption tripled between 1961 and 2002. Globally, food demand is expected to grow by 70-90% by 2050, without increases in water productivity.



### How much water do

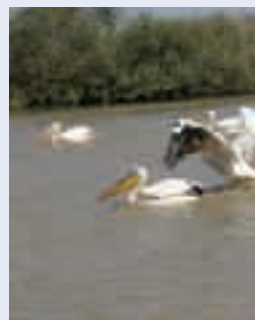
On average, people in drink between 2 to 5 liters of water to "eat" about 3,000 liters of food they consume.



Photo Credit Luna Bharati

### Water for power generation

The inter-linkages between water security and energy are still badly understood. The largest single use of water by industry is for cooling in thermal power generation. Water for biofuel production if not handled in a sustainable way, can pose a threat to future water and food security.



# Water Gone?

**Water stress is global, but its impacts occur regionally and locally**

The impacts of water scarcity affect a broad range of stakeholders in a wide variety of ways. It affects commercial operators, the health of communities, the profitability of local industries, the ability of local agriculture to deliver crops needed by people and the economy... and finally the ability of the natural environment to function optimally.



Photo Credit: Matthew McCartney

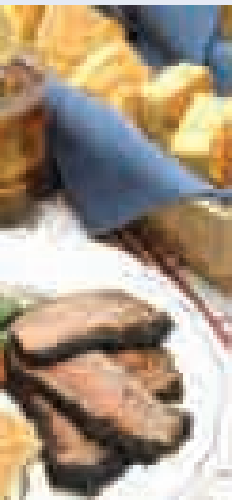


Photo Credit: Anula Manikie

**How much water do we “eat”?**

In developed countries, people consume 100 liters per day, but they consume 10 liters of water per day in the developing world.

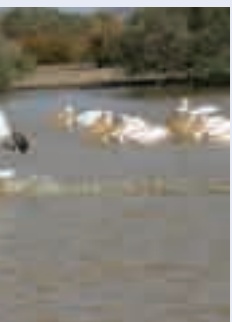


Photo Credit: Sanjini de Silva



Photo Credit: Sarah Carriger

## Water and climate change

According to the latest Inter governmental Panel on Climate Change (IPCC) Report, by 2020 between 75 and 250 million people will be exposed to increased water stress, while rainfed agriculture could be reduced by up to 50% in Africa.

## Water for the environment

Half of the world's wetlands have disappeared over the last century. Some rivers have extended periods of zero flow. It is essential to understand how much water can be taken from a river before its ability to meet social, economic and ecological needs is hindered.

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## Ideas for Action from the Davos Discussion

The Davos Coalition presented three ideas for action:

- 1. Raise global awareness of water challenges** in the business and political domains to motivate and catalyze action.
- 2. Leverage business communities.** The business community should take leadership in water and more companies should sign the CEO Water Mandate launched at the UN Global Leadership Forum.
- 3. Support multi-stakeholder policy dialogues** as part of Corporate Global Citizenship. The dialogues will focus on water governance, incentives for more efficient water use and water allocation.

## Water Also Kills

The Asia Pacific Region accounted for 80% of the world's total deaths due to water-related disasters in the period 2001-2005 (Asia Pacific Water Forum).

### How much water goes on goods and services?

**300**

liters for every car wash

**2,700**

liters to make a cotton T-shirt

**2,400**

liters of water to produce one liter of maize-based ethanol in China

**1-2.5**

liters of water to process one liter of gasoline.





## Straight Talk:

# Improving Agricultural Water Productivity in the Krishna Basin

*In India, management of water resources is the responsibility of individual states with the exception of transboundary rivers that cut across states which come under the jurisdiction of the central government. In 1969, the Krishna Water Disputes Tribunal was set up to allocate water among the three states that share the Krishna Basin—Andhra Pradesh, Karnataka and Maharashtra. However, demographic dynamics and economic development (especially rapid urbanization and the development of irrigation projects) during the past 20 years have led to growing pressure on water resources. Added to the problems of water sharing between states are other questions of local water management, internal to individual states.*

*The need for efficient and sustainable water allocation policies has become more important than ever. Finding ways to meet growing demand, and also to achieve positive economic outcomes without creating negative impacts on the environment, needs a holistic approach.*

*IWMI's work in the Krishna Basin recognizes that an integrated approach which considers the physical, social and economic aspects of water resource management can provide policymakers with essential information needed to make rational resource allocation decisions.*

Luna Bharati is a researcher in Hydrology and Water Resources at IWMI. In this issue of Water Figures she talks to Sharni Jayawardena on IWMI's research challenges in the Krishna Basin. She is currently project leader of the ACIAR funded project on water allocation for improved agricultural productivity in the Krishna Basin. The project team consists of IWMI, University of Melbourne, Australia and The Jawaharlal Nehru Technological University, India.

**In the Krishna Basin IWMI is discussing water management in a context where three states are discussing water sharing. How challenging has this been?**

Quite challenging. As the three riparian states, i.e. Maharashtra, Karnataka and Andhra Pradesh, are negotiating new water allocation arrangements, it is very important for the project team to maintain good working relations with all three states so that first of all, they make data and information available to us, and second, accept and utilize the key outputs from our studies.

**IWMI's role is not just making technical prescriptions but also institutional ones. And so it takes**

**not just hydrology into account but also the socioeconomic and environmental aspects of water resources and its management. How did the project do this?**

To meet the project objectives of improving water productivity in the water scarce Krishna River Basin and determining the implications of different water allocation scenarios for future water allocation options, food production and long-term resource sustainability, we first needed to quantify water availability and water use by understanding the hydrological regime as well as other physical conditions in the basin. The next step was to analyze different water allocation scenarios. In addition, we are doing an analysis that links the water allocation model with an economic framework with the capability to measure the regional and inter-sectoral impacts of different distributions of water with particular emphasis on water productivity and environmental outcomes.

The study has demonstrated that it is not only the availability of the physical resource that is crucial in explaining the evolution of water use but, as water has become a disputed and highly politicized object, the allocation of water is strongly shaped by the social and political conditions of a region. Thus, there is now a greater awareness of the need to better understand the socioeconomic and institutional changes that occur in a closing basin and to come up with effective interventions to address the scarcity of water resources in the basin. This study has highlighted this issue and two separate research projects focusing on this aspect are being developed.

**The end of the first phase of the project saw a series of stakeholder meetings to reflect on—and recommend. What was this experience like?**

Dialogue with stakeholders has been key in this project. Project stakeholder



Photo Credit: B. K. Anand

IWMI researcher Luna Bharati on a field visit to the Krishna Basin.

workshops were organized with close participation from state and central government agencies and the collaborating scientists in India and Australia. Stakeholders' workshops were organized in Hyderabad in November 2004, 2005 and 2006 and again in Hyderabad, Mumbai and Bangalore in February, 2008 to discuss alternate allocation scenarios and possible benefits. This has facilitated closer interaction between the stakeholders and the researchers. As the three states are still negotiating the new terms for water sharing, analysis and results from this project are being reviewed and discussed by the stakeholders as IWMI is now being seen as an independent organization without biases towards any state. We

have also started getting requests from government agencies to study specific issues related to their particular state such as to calculate water availability and its level of certainty to establish the usable water as well as to estimate the minimum water required to sustain the livelihoods of the agricultural population.

**There's a lot of effort and science that's gone into developing frameworks to support decision making to improve water productivity. But IWMI has clearly stated that one of its key goals in contributing to improved equity—i.e. promoting fairer distribution of water resources. How far do you think we are succeeding?**

During the last stakeholder workshop, some of the stakeholders had also brought up the issue of equity and water poverty in relation to water allocation. As the project objective is to test various water allocation options to achieve not only the economic optimum, but also realize other welfare and environmental benefits, we are planning to also include these scenarios in the analysis.

Due to the fact that the Krishna Basin Tribunal is currently negotiating water allocation for the three riparian states, the analysis and outputs generated from this project are very timely and have high impact potential. Therefore, we appreciate the support of ACIAR to fund this project.



# Safer Sanitation to Counter Wastewater Woes

## An Update on WASPA's Work in Sri Lanka and Bangladesh

Throughout the developing world, as much as 3.5 million hectares of land are irrigated with raw and diluted wastewater. While the practice plays an important role in food supply, poverty alleviation and local livelihoods, particularly in urban and peri-urban areas, wastewater irrigation is largely unrecognized in any social statistics or policies. IWMI's research has highlighted the need to develop practical, cost-effective management options that maintain the advantages of urban waste resources while protecting environmental and human health.

IWMI, the Stockholm Environment Institute, the International Water and Sanitation Centre (IRC) together with the COSI Foundation for Technical Cooperation and NGO Forum for Drinking Water Supply and Sanitation have been working with local government and community members in Kurunegala City in Sri Lanka and Rajshahi in Bangladesh, for two years, to develop plans to better manage wastewater from the city, to reduce the risks to downstream communities and to improve the living conditions

of low income groups in the city. The Wastewater, Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA) project, funded by the EU, is improving latrines and water supply in certain areas, as well as working closely with industries and the national water boards in the two countries to reduce industrial waste. These physical interventions are linked with knowledge sharing, training and awareness programs undertaken together with the local government authorities.

The use of wastewater for irrigation is important for many farmers who do not have access to clean irrigation water, but if it is not managed properly there are a number of health risks. A series of workshops for government officials, NGOs and practitioners at the local and national level were held in each of the cities and led by Prof. Thor Axel Stenström who works with the Stockholm Environment Institute in Sweden. Both the workshops discussed the options, assessments and potential barriers to the use of wastewater and treated excreta in agriculture. Professor Stenström, also an advisor to the WHO, presented the



Photo Credit: Alexandra Clemett

Wastewater flowing from a city in Sri Lanka. IWMI works with government and community members to develop better wastewater management practices.

“WHO Guidelines for the Safe Use of Excreta, Greywater and Wastewater in Agriculture”, which IWMI helped shape. He also discussed current management options to prevent disease transmission, including different sanitation system solutions. The workshops were attended by government officials, NGOs, academics and practitioners. We hope this effort will stimulate renewed efforts to improve sanitation in the 2008 International Year of Sanitation.

A section of the Krishna River in India. IWMI is promoting an integrated approach taking into consideration the physical, social and economic aspects of water resource management.



## Recent Publications

For on-line access to IWMI Research Reports and Working Papers, see <http://www.iwmi.cgiar.org/Publications/index.aspx>

### IWMI Research Reports

1. Amarasinghe, Upali; Shah, Tushaar; Turrall, Hugh; Anand, B. K. 2007. India's water future to 2025-2050: business-as-usual scenario and deviations. Colombo, Sri Lanka: IWMI. 41p. (IWMI Research Report 123)
2. Saleth, Rathinasamy Maria; Dinar, A.; Neubert, S.; Kamaiah, B.; Manoharan, S.; Abayawardana, Sarath; Ariyaratne, Ranjith; de Silva, S. 2007. Institutions, impact synergies and food security: a methodology with results from the Kala Oya Basin, Sri Lanka. Colombo, Sri Lanka: IWMI. 46p. (IWMI Research Report 124)
3. Smakhtin, Vladimir; Gamage, Nilantha; Bharati, Luna. 2007. Hydrological and environmental issues of interbasin water transfers in India: a case of the Krishna River Basin. Colombo, Sri Lanka: IWMI. 26p. (IWMI Research Report 120)
4. Venot, Jean-Philippe; Turrall, Hugh; Samad, Madar; Molle, Francois. 2007. Shifting waterscapes: explaining basin closure in the Lower Krishna Basin, South India. Colombo, Sri Lanka: International Water Management Institute. 50p. (IWMI Research Report 121)
5. Zomer, Robert J.; Bossio, Deborah A.; Trabucco, Antonio; Yuanjie, Li; Gupta, Diwan C.; Singh, Virendra P. 2007. Trees and water: smallholder agroforestry on irrigated lands in Northern India. Colombo, Sri Lanka: International Water Management Institute. 41p. (IWMI Research Report 122)

### Working Papers

1. Awulachew, Seleshi Bekele; Yilma, A. D.; Loulseged, M.; Loiskandl, W.; Ayana, M.; Alamirew, T. 2007. Water resources and irrigation development in Ethiopia. Colombo, Sri Lanka: IWMI. 66p. (IWMI Working Paper 123)
2. Panabokke, Chris R.; Ariyaratne, B. Ranjith; Seneviratne, A.; Wijekoon, D.; Molle, Francois. 2007. Characterization and monitoring of the regolith aquifer within four selected cascades (sub-watersheds) of the Malala Oya Basin. Colombo, Sri Lanka: IWMI. 38p. (IWMI Working Paper 122)

### Books and Book Chapters

1. Bergkamp, Ger; Sadoff, Claudia W. 2008. Water in a sustainable economy. In 2008 State of the world: Innovations for a sustainable economy. 25th Anniversary Edition. Washington, DC, USA: Worldwatch Institute. Special Section: Paying for nature's services. pp.107-238.
2. Saleth, Rathinasamy Maria; Dinar, A.; Neubert, S. 2008. Evaluating institution-impact interactions in the context of millennium development goals: Analytical framework with empirical results. In Koundouri, P. (Ed.), Coping with water deficiency: From research to policy making. Dordrecht, Netherlands: Springer. pp.189-212.
3. Saleth, Rathinasamy Maria; Dinar, Ariel. 2008. Quantifying institutional impacts and development synergies in water resource programs: A methodology with application to the Kala Oya Basin, Sri Lanka. Washington, DC, USA: World Bank. Development Research Group. Sustainable Rural & Urban Development Team. 66p. (World Bank Policy Research Working Paper 4498)

### IWMI Articles in Journals

1. Bhaduri, Anik; Barbier, E. B. 2008. International water transfer and sharing: The case of the Ganges River. *Environment and Development Economics*, 13:29-51.
2. Clement, Floriane; Amezaga, J. M. 2008. Linking reforestation policies with land use change in northern Vietnam: why local factors matter. *Geoforum*, 39: 265-277.
3. de Fraiture, Charlotte; Giordano, Mark; Liao, Yongsong. 2008. Biofuels and implications for agricultural water use: blue impacts of green energy. *Water Policy*, 10(Suppl.1): 67-81.
4. Falkenmark, Malin; Molden, David. 2008 Wake Up to Realities of River Basin Closure, *International Journal of Water Resources Development*, 24(2):201-215.
5. François Molle. 2008. Why Enough Is Never Enough: The Societal Determinants of River Basin Closure, *International Journal of Water Resources Development*, 24(2):217-226.
6. Hellegers, Petra; Zilberman, D.; Steduto, P.; McCornick, Peter. 2008. Interactions between water, energy, food and environment: evolving perspectives and policy issues. *Water Policy*, 10(Suppl.1): 1-10.
7. Molle, Francois; Jayakody, Priyantha; Ariyaratne, Ranjith; Somatilake, H. S. 2008. Irrigation versus hydropower: sectoral conflicts in southern Sri Lanka. *Water Policy*, 10(Suppl.1): 37-50.
8. Mukherji, Aditi. 2008. Poverty, groundwater, electricity and agrarian politics: Understanding the linkages in West Bengal. *Transforming India*, January-March:8-10.
9. Nangia, Vinay; Gowda, P. H.; Mulla, D. J.; Sands, G. R. 2008. Water quality modeling of fertilizer management impacts on nitrate losses in tile drains at the field scale. *Journal of Environmental Quality*, 37(2): 296-307.
10. Pattanaik, C.; Narendra Prasad, S.; Nagabhatla, Nidhi; Finlayson, Max. 2008. Kolleru regains its grandeur. *Current Science*, 94(1):9-10.
11. Shah, Tushaar; Verma, Shilp. 2008. Co-management of electricity and groundwater: an assessment of Gujarat's Jyotigram Scheme. *Economic & Political Weekly*, 43(7): 59-66.
12. Smakhtin, Vladimir. 2008. Basin Closure and Environmental Flow Requirements *International Journal of Water Resources Development*, 24(2):227-233
13. Simmons, Robert W.; Noble, Andrew D.; Pongsakul, P.; Sukreeyapongse, O.; Chinabut, N. 2008. Cadmium hazard mapping methodology (IRR-CAD) for rapid risk assessment: Development and practical application. *Environmental Geochemistry and Health*, 29p.
14. Venot, Jean-Philippe; Molle, François; Courcier, Remy. 2008. Dealing with Closed Basins: The Case of the Lower Jordan River Basin, *International Journal of Water Resources Development*, 24(2):247-263.

