WATER FIGURES

TURNING RESEARCH INTO DEVELOPMENT

QUARTERLY NEWSLETTER OF THE INTERNATIONAL WATER MANAGEMENT INSTITUTE

CONTENTS

ISSUE 3
2007

ANNOUNCEMENT

Contributing to the Biofuels Debate

Read IWMI's position piece on the Biofuels debate, "Biofuels and implications for agricultural water use: blue impacts of green energy"

Written by Charlotte de Fraiture, Mark Giordano and Liao Yongsong

www.iwmi.org

IWMI
International Water Management Institute
www.iwmi.org

EDITORIAL

WATER FIGURES ISSUE 3, 2007

Water: High Priority on the Development Agenda

The recent proliferation of reports from leading development organizations focused on water, is drawing global attention to water management, and beginning to show how water traverses all areas of development. The first UN Water Development Report was launched in 2003's "Water for People, Water for Life", and inspired the United Nations to proclaim 2005 to 2015 the International Decade for Action, 'Water for Life'.Since the announcement, there is a marked effort to put water at the heart of development as an issue that is pivotal to all discussions about human beings, the environment and development.

The Millennium Ecosystem Assessment (MA) is a product of 4 years of work from scientists across the world that examined ecosystem changes that have occurred and the consequences of these changes for human well-being. Water resources play an important role in the assessment, particularly in efforts to address how ecosystems can be conserved for the benefit of poor people, who are most vulnerable to degradation of ecosystem services. The MA frames its discussion on water by regarding it as a 'service', providing one of the essential components for sustaining ecosystem services to human beings. In this way, it places emphasis on the delicate balance that is required to make ecosystem services work for human and environmental well-being.

The 2006 Human Development Report takes the human development perspective on the water crisis and examines the integral role that water plays in achieving the MDGs and the goals of water development. With an image of a tap that is attached to the loop of a padlock, the report emphasizes the security aspect that controlling of water resources brings. Water deprivation contributes to risk and vulnerability and exacerbates poverty. As an indicator of human development, water and sanitation are prioritized on the list of concerns in the report, as an immediate issue affecting 1.2 billion people, of which a disproportionate number comprises women and children. Governance of water is also an issue that receives serious attention in the report—the question of equitable and effective systems for water delivery. It stresses on transboundary cooperation in sharing of water, and also the competition for water resources between sectors within countries as important governance issues.

Finally, The Comprehensive Assessment of Water Management in Agriculture's (CA) book was launched earlier this year. In this flagship publication, 'Water for Food, Water for Life', the focus is on the world's present need and future concerns. Although the assessment is a product of a 5 year effort that looks at the history of water management, and development over the last 50 years, it constantly emphasizes new challenges and directions for the future. Its focus is more to look at the water-food-environment nexus and the particular costs that are being accrued as human consumption competes with the environmental need. Certainly, water figures greatly in future food , livelihood and environmental security and will also play a key role in adapting to the new challenges of climate change.

Samyuktha Varma
Editor

The choice of WATER FIGURES as the name of our quarterly newsletter arises from its ability to communicate more than one meaning: "Water figures in the scheme of things…"; "WATER FIGURES as a reference to the science of water management"; "WATER FIGURES as a visual representation of the spaces the resource occupies and the shapes it takes".

EVENTS

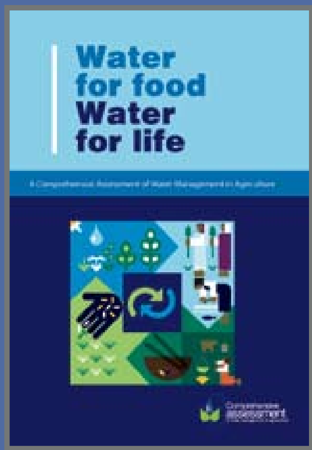
1st WORLD AQUA CONGRESS

Delhi, India, 28-30 November, 2007
Sustainable Water Management: Challenges Technologies Solutions

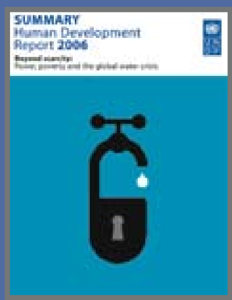
UNITED NATIONS CLIMATE CHANGE CONFERENCE

Bali, Indonesia 3-14 December, 2007
Over two weeks the conference hosts sessions of the Conference of the Parties to the UNFCCC, its subsidiary bodies as well as the Meeting of the Parties of the Kyoto Protocol.

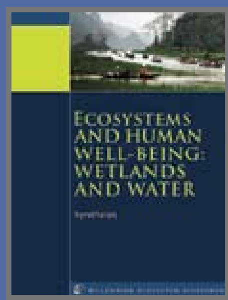
http://unfccc.int/meetings/cop_13/items/4049.php



http://www.iwmi.cgiar.org/assessment



http://hdr.undp.org/hdr2006



http://www.millenniumassessment.org

PRODUCTION CREDITS

EDITOR Samyuktha Varma
samyuktha.varma@cgiar.org

LAYOUT Sumith Fernando
s.fernando@cgiar.org

COVER PHOTO Aditi Mukherji

IWMI
Headquarters
127 Sunil Mawatha, Pelawatte
Battaramulla, Sri Lanka

MAILING ADDRESS:
P.O. Box 2075, Colombo, Sri Lanka
Telephone: +94-11-2880000
Fax: +94-11-2786854

EMAIL: iwmi@cgiar.org

Changing Consumption Patterns: What does it mean for future food and water demand in India?

IWMI Research Report 119

Written by UPALI A. AMARASINGHE, TUSHAAR SHAH AND OM PRAKASH SINGH

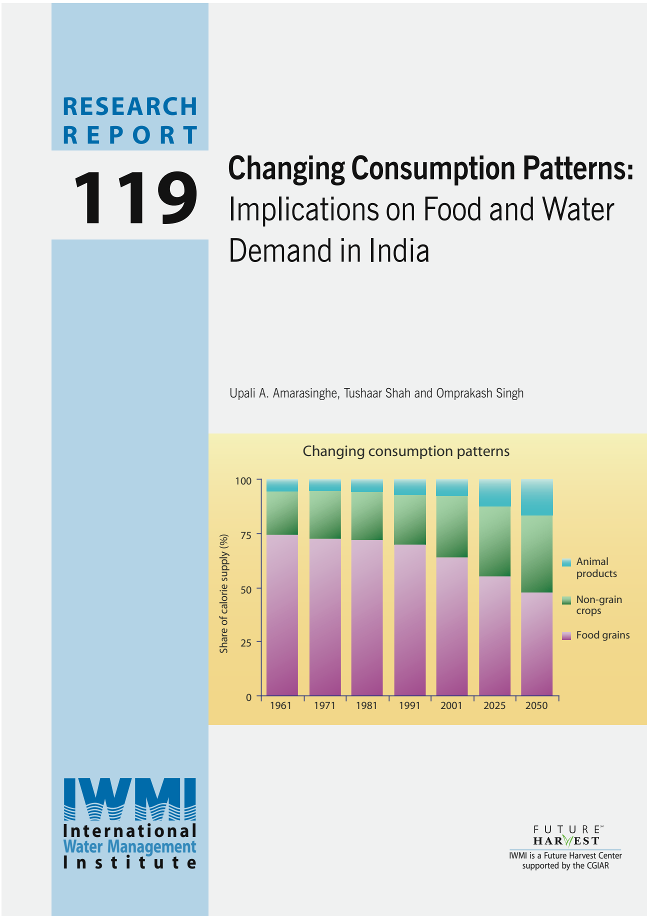
Rising incomes and urbanization are changing food consumption patterns in India, with non-grain crops and animal products making an increasing contribution to the daily calorie supply. Grain provided 65 percent of people's calorie intake in 2000, but this figure is expected to drop to 55 percent in 2025 and to less than 50 percent by 2050.

The Research Report assesses India's changing food consumption patterns and their implications for future food and water demand. According to study projections, the total calorie supply would continue to increase, but the dominance of food grains in the consumption basket will probably decrease. However,, the total grain demand is likely to increase with the growing feed demand for livestock.

An even greater challenge than meeting the increasing demand for feed grain is likely to be meeting the increasing demand for non-grain crops. The study shows the need for diversifying future agricultural production, especially to high-value, non-grain crops.

The implications of changing consumption patterns are assessed through consumptive water use (CWU) assuming a scenario of full or partial food self-sufficiency. The research points out that national-level scenarios show that India can meet most of its future water demand with a modest increase in water productivity in both irrigated and rainfed crops. However, to determine exactly where and how this can be achieved, more research is needed. Recommended areas of research include:

- Identifying high productivity zones and high potential locations for increasing the water productivity of grain crops.
- Identifying suitable cropping patterns, which generate higher value for every drop of water consumed.
- Encouraging and increasing diversification, from grain to non-grain crops, in locations where returns from water use are low at present.
- Importing part of the demand for certain crops, or increasing virtual water trade, where differences in irrigated and rainfed water productivities are high, or where water productivity is low under both conditions. Virtual trade is a better option than using scarce irrigation water resources inefficiently. An increase in trade is not necessarily between countries; it can be between states. The trade can be for crops where there is no significant gain by irrigating them within India. Maize and oil seeds are good examples.
- Increasing the beneficial use of present irrigation diversions. Less than half of the irrigation withdrawals are beneficially consumed at present. Much of the additional CWU demand in the future can be met from the non-beneficial depletions at present. This can be done only in basins where reuse of non-beneficial diversions may not have any significant impact on downstream or other uses. Appropriate water saving techniques could offer significant opportunities here.



IWMI Research Reports are available on the website **www.iwmi.org** and may be copied freely and cited with due acknowledgement.

A view on the poverty reduction potential of groundwater irrigation and rural electrification in eastern India

ADITI MUKHERJI

Groundwater, electricity and poverty

Although the link between groundwater, electricity and poverty reduction may not be the most straightforward, in regions of abundant rainfall and good alluvial aquifers, groundwater irrigation can be a powerful catalyst in reducing poverty. Studies done in Eastern India the states that include eastern Uttar Pradesh, Bihar, West Bengal, Orissa and Assamt have shown that when affordable electricity is provided to groundwater irrigators there has been a significant impact on poverty., Groundwater currently irrigates over 60% of India's net irrigated area of 58 million ha or so and it contributes more to agricultural production than all other sources of irrigation put together. However, the downside of this has been increasingly unsustainable use in certain pockets of the country – although less so in eastern India, where under-utilization of groundwater is a more pressing issue.

In the 1980s and early 1990s, many of the eastern states used groundwater which led to rapid agricultural growth as seen in West Bengal. However, by the mid 1990s, the groundwater irrigation boom in eastern India had halted, as it had in parts of arid and semi-arid India. While in other parts of India decelerated groundwater development came about through groundwater depletion and over-exploitation, this was not the case in eastern India where ample rainfall and alluviam -rich aquifers ensured that much of the groundwater was recharged. Yet, eastern India saw a decline in growth of irrigation wells and tubewells, which could be attributed to policies such as rural de-electrification, removal of capital subsidies on electrification and complicated groundwater permit systems. These policies were influenced by prevalent discourses in groundwater that stressed scarcity, depletion and over-exploitation, despite the fact that these factors were not relevant for the water abundant eastern India.

The dominant discourse

In West Bengal, a state that receives abundant rainfall (1500 to 2500 cm annually), rich alluvial aquifers and high groundwater potential ensures around 31 billion cubic meters (BCM). In terms of groundwater endowments per unit of net cultivable area, West Bengal ranks second in the country. However West Bengal' groundwater policies are in sharp

Photo Credit Aditi Mukherji

Photo Credit Aditi Mukherji

Diesel pumps are been increasingly used for vegetable cultivation in eastern India but rising diesel costs are squeezing farmers' profits.

contrast to those of groundwater depleted states. Farmers in West Bengal have the lowest percentage of electric pumps to total pumps (10.1%) in the country and pay some of the highest electricity tariffs in India. Farmers in more arid states such as Punjab, Haryana, Tamil Nadu and Andhra Pradesh get electricity free of charge.

In the 1980s and 1990s the lack of rural electrification did not affect groundwater irrigation much because diesel was cheap, subsidised and affordable. However, over the last few years, with a major rise in diesel prices, many groundwater irrigators have been put out of business. A decline in the rate of pump electrification in the state has also occurred, mainly due to withdrawal of capital subsidy on electrification and new rules for procuring a clearance certificate from the State Water Investigation Directorate (SWID).

All these policies have had a negative effect on the growth in groundwater irrigation and consequently on the agricultural economy as a whole. Given that groundwater irrigation played a crucial role in agricultural development in the state and that agricultural growth is also positively related to poverty alleviation, any slowdown in the former without recompense in other sectors can be detrimental to poor farmers. The final outcome is somewhat of a paradox: economic groundwater scarcity and concentrated rural poverty in a land of abundant rainfall and groundwater.

Going by the policy making discourse in the state, it would seem as if West Bengal were on the brink of a major groundwater disaster. Undoubtedly, the global concern on arsenic contamination in groundwater explains part of the state's cautious policies, but given that arsenic is largely a drinking water threat that can be addressed more simply, the restrictive policies of the state do not seem to fit. As West Bengal has one of the higher poverty ratios in India, groundwater can and once did play an important poverty-alleviating role.

A part of the explanation also lies in agrarian politics, shown by the presence or absence of farmer lobbies. Discussions on depletion and scarcity that have influenced policies in West Bengal have faced very little protest from farmers. Groundwater policies in India are closely tied to agrarian politics and issues of representation, In West Bengal, the dominant farmer organization has strong political affiliation with the ruling party. The state is also seen to pursue policies determined by urban intelligentsia that are far removed from rural realities. Such pro-resource and anti-farmer policies would be impossible to institute in states such as Punjab, Gujarat and Andhra Pradesh – all of which have strong farmer lobbies.

Given the rich groundwater resource condition in the state, coupled with high rates of rural poverty, it can be argued that increasing groundwater use through rapid rural electrification is one of the best ways of combating poverty. A concern that is often expressed is the fear that encouraging groundwater irrigation through electrification can lead to state electricity boards going bankrupt as has happened in Gujarat and Punjab. But such an eventuality need not occur provided that electricity is not given free of cost or subsidised. West Bengal already has one of the highest flat rate tariffs in India and this has encouraged pro-active groundwater markets in the state. These groundwater markets provide access to irrigation to those who do not have any means of irrigation and outcomes are largely equitable and efficient. Continuing this high flat rate tariff along with easing the entire process of rural electrification and providing one- time capital subsidy would encourage groundwater use and consequently make a dent in the high poverty figures in the state.

Aditi Mukherji is a Post-doctoral fellow (Economics) based at IWMI HQ. a.mukherji@cgiar.org

Contribution to the Biofuels debate

On the one hand there is consistent and vocal opposition to biofuels from writers such as George Monbiot who sees an imminent "*humanitarian and environmental disaster*" in the enthusiasm for biofuels. His main point in a recent article is that the growing demand for biofuels is luring poor countries to produce larger amounts of crop for biofuels export rather than to meet their food needs. However it detracts from a more fundamental question: if agriculture itself raises questions about environmental degradation, can biofuel production really be green?

On the other, serious commitments to grow biofuels from countries such as Brazil and the United States indicate that many countries are well on their way reaching the targets they have set for 'green energy'. Although the costs of production in terms of the price of technology to improve production, costs and supply of crops as well as the competition from new alternative energy and the price of oil are all listed as important factors to consider, this has no detracted support from countries promoting biofuel use while aiming to grab a share of the market.

One of the key determinants agricultural production is of course water. In Monbiot's portrayal of the problem citing the example of Swaziland, the district in which land has been allocated to grow cassava for biofuels has been worst affected by drought. IWMI's work in the last months has been drawing attention to the serious affects of biofuel production in water stress areas. IWMI researcher Charlotte de Fraiture's opinion piece featured in SciDev.net cautions the biofuels bandwagon while disclosing the potential pitfalls and tradeoffs in the context of rapidly urbanizing countries such as India and China.

The longer paper on 'Biofuels and agricultural water use: blue impacts of green energy' has added insight into the ongoing discussions on the effects of biofuel crop production on water resources. Based on research from the Comprehensive Assessment of Water Management in Agriculture, the paper highlights some of the problems of growing biofuel crops in areas where there is water scarcity using examples from India and China.

Charlotte sets out the purpose of the paper:
"There are many factors playing a role in the design of biofuel policy: economic and political factors, energy considerations, issues of natural resources and the environment. Water is one of the many factors. But in some countries, particularly the ones that are already suffering from water scarcity, water is extremely important in the discussions around biofuels. With this study we wanted to draw attention to water implications of green energy."

The paper also poses the question: Are the tradeoffs to free up sufficient water and land to produce biofuel crops worth making? These include making difficult changes such as importing large amounts of food to accommodate demand and make space for biofuels production.

Read IWMI's position piece on the Biofuels debate, "Biofuels and implications for agricultural water use: blue impacts of green energy" written by Charlotte de Fraiture, Mark Giordano and Liao Yongsong. www.iwmi.org

NEW BRIEFS FOCUS ON AFRICA

http://www.iwmi.cgiar.org/Publications/Other/Pdf/SSI_Brief.pdf

http://www.iwmi.cgiar.org/africa/East/pdf/Ethiopia%20Brief-Final.pdf

Maize and cassava are the major sources of sediments from catchments

C. VALENTIN[1], A. BOOSANER[2], T. DE GUZMAN[3], K. PHACHOMPHONH[4], K. SUBAGYONO[5], T. TOAN[6]

Runoff and soil erosion are often not only the primary consequences and symptoms of land mismanagement but are also involved in negative off-site impacts such as flooding, pollution and siltation of water bodies and reservoirs. Thus runoff and soil erosion resulting from changes in land use and/or climatic conditions concerns not only upland farmers but also the users of water resources downstream. Indeed, although land degradation is often associated with poverty especially in mountainous regions dominated by people who are often politically disempowered and economically marginalized, public interest in management of uplands emerged mainly from a realization that environmental degradation of these lands affects often richer communities

In order to address these issues and provide sound data on the extent of accelerated soil erosion resulting from rapid land use changes at an appropriate scale, a regional network called 'the Management of Soil Erosion Consortium' (MSEC) was established towards the end of the 90's. Five countries (Indonesia, the Lao PDR, the Philippines, Thailand and Vietnam), the International Water Management Institute (IWMI) and the French Institut de Recherche pour le Developpment (IRD) have been implementing a long term research program aimed at monitoring changes in farming practises and the resulting runoff and sediment yields from 27 catchments and sub-catchments.

Data clearly demonstrate that annual crops without conservation practises, promote soil erosion at the catchment scale. Annual crops in upland catchments have therefore an off-site impact on water quality due to elevated turbidity. Among annual crops, maize, and cassava are the most erosive. This is due to the rather low vegetative cover these crops provide and the need for repeated weeding. Cassava is often used to replace the main staple crop (usually upland rice) because it is less demanding. It is increasingly being produced as a source of bio-ethanol. In Vietnam, sediment yields were greatly reduced following replacement of cassava (7.3 ton ha-1.yr-1) by tree plantations (1.0 ton ha-1.yr-1) and a fodder crop (0.7 ton ha-1.yr-1). The recent development of maize in Southeast Asia is associated with rising prices and improved market access. This process is likely to be exacerbated by the increasing demand for biofuel. In the Laotian catchment, soil erosion has increased from 0.9 to 11.3 ton ha-1 yr-1 under the prevailing system of 1 year of cultivation, 8 years of fallow, due to the shortening of the fallow period (2 years) and the recent cultivation of maize. More often, farmers tend to encroach on tree plantations or to destroy them to extend maize, as exemplified in Indonesia and Philippines. In the Philippines, the traditional mechanised method for cultivating maize parallel to the hillslope is highly erosive (36.2 ton ha-1.yr-1). In Indonesia, 25% of land originally under Rambutan plantation was converted to cassava with a resulting increase in sediment yield from 2.9 to 13.1 ton ha-1.yr-1. In Thailand, sediment yields, already high with soybean/mungbean (4.9 ton ha-1yr-1), even under fruit trees (3.0 ton ha-1yr-1), more than doubled following these land use changes (11.7 ton ha-1yr-1). On average any increase of 10% of land cropped with maize or cassava led to an increase of 1.5 ton ha-1yr-1). By contrast, no significant correlation was found between the proportion of the catchments cultivated in upland rice and sediment yield.

The Association of Southeast Asian Nations (ASEAN) and its six regional partners, including China and India have recently signed (15th January 2007) the Cebu Declaration on East Asian Energy Security. This agreement lists a series of goals to provide reliable, adequate and affordable energy supplies to the region, calling for, among others, the development of renewable energy such as in biofuels. In addition to the trade-off between using land to grow food and using it to grow fuel, policy makers must realize that growing more maize and cassavas will lead to a dramatic increase in sediment yields from upland catchments with economical damage to infrastructures and communities downstream. If these biofuels (sometimes referred to as 'deforestation diesel') take off in already degraded uplands of Southeast Asia, they may cause an environmental disaster, the opposite of the environmentally friendly primary objective. In addition, maize and/or cassava monocultures would leave local people more vulnerable to market fluctuations, which may delay poverty alleviation in these uplands.

1. Principal Scientist, seconded to IWMI, IRD, Institut de Recherche pour le Développement, UR176, France,
2. NPWPCD, National Park, Wildlife and Plant Conservation Department, Thailand
3. PCARRD, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines
4. NAFRI, National Agriculture and Forestry Research Institute, Lao PDR
5. IAHRI, Indonesian Agroclimate and Hydrology Research Institute, Indonesia
6. NISF, National Institute for Soils and Fertilizers, Vietnam

Bare soil surface in a steep slope field of northern Laos in early rainy season (June). Photo Credit C. Valentin

Recent Publications

For on-line access to IWMI Research Reports and Working Papers, see **http://www.iwmi.cgiar.org/pubs/mindex.htm**

IWMI Research Reports

1.Biggs, Trent; Gaur, Anju; Scott, C.; Thenkabail, Prasad; Gangadhara Rao, Parthasaradhi; Gumma, Murali Krishna; Acharya, Sreedhar; Turral, Hugh. 2007. Closing of the Krishna Basin: Irrigation, streamflow depletion and macroscale hydrology. Colombo, Sri Lanka: IWMI. 38p. (IWMI Research Report 111)

2.Cullis, J.; van Koppen, Barbara. 2007. Applying the Gini Coefficient to measure inequality of water use in the Olifants River water management area, South Africa. Colombo, Sri Lanka: IWMI. 19p. (IWMI Research Report 113)

3.Lankford, B. A.; Merrey, Douglas; Cour, J.; Hepworth, N. 2007. From integrated to expedient: An adaptive framework for river basin management in developing countries. Colombo, Sri Lanka: IWMI. 37p. (IWMI Research Report 110)

4.Clement, Floriane; Amezaga, Jaime M.; Orange, Didier; Toan, Tran Duc. 2007. The impact of government policies on land use in Northern Vietnam: An institutional approach for understanding farmer decisions. Colombo, Sri Lanka: IWMI. 21p. (IWMI Research Report 112)

Comprehensive Assessment Research Reports

1.Arthington, A. H.; Baran, E.; Brown, C. A.; Dugan, P.; Halls, A. S.; King, J.M .; Minte-Vera, C. V.; Tharme, Rebecca E.; Welcomme, R. L. 2007. Water requirements of floodplain rivers and fisheries: Existing decision support tools and pathways for development. Colombo, Sri Lanka: IWMI. 68p. (Comprehensive Assessment of Water Management in Agriculture Research Report 17)

Working paper

1.Ul Hassan, Mehmood; Qureshi, Asad Sarwar; Heydari, N. 2007. A proposed framework for irrigation management transfer in Iran: Lessons from Asia and Iran. Colombo, Sri Lanka: IWMI. 31p. (IWMI working paper

2.118) McCartney, Matthew. 2007. Decision support systems for large dam planning and operation in Africa. Colombo, Sri Lanka: IWMI. 41p. (IWMI Working Paper 119)

3.Smakhtin, Vladimir; Arunachalam, M.; Behera, S.; Chatterjee, A.; Das, S.; Gautam, P.; Joshi, G. D.; Sivaramakrishnan, K. G.; Unni, K. S. 2007. Developing procedures for assessment of ecological status of Indian River Basins in the context of environmental water requirements. Colombo, Sri Lanka: IWMI. 34p. (IWMI Research Report 114)

Books and book chapters

1.Aloysius, Noel. 2006. Climate change and its impacts on evapotranspiration: A temporal and spatial analysis for India. Thesis submitted to the Graduate Faculty of the University of North Dakota in partial fulfillment of the requirements for the degree of Master of Science. 87p.

2.Bossio, Deborah; Critchley, W.; Geheb, K.; van Lynden, G.; Mati, B.; Bhushan, P.; Hellin, J.; Jacks, G.; Kolff, A.; Nachtergaele, F.; Neely, C.; Peden, D.; Rubiano, J.; Shepherd, G.; Valentin, Christian; Walsh, M. 2007. Conserving land, protecting water. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.551-583.

3.Bouman, B.; Barker, R.; Humphreys, E.; Tuong, T. P.; Atlin, G.; Bennett, J.; Dawe, D.; Dittert, K.; Dobermann, A.; Facon, T.; Fujimoto, N.; Gupta, R.; Haefele, S.; Hosen, Y.; Ismail, A.; Johnson, D.; Johnson, S.; Khan, S.; Shan, L.; Masih, Ilyas; Matsuno, Y.; Pandey, S.; Peng, S.; Muthukumarisami, T.; Wassman, R. 2007. Rice: Feeding the billions. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.515-549.

4.Castillo, G. E.; Namara, Regassa; Ravnborg, H. M.; Hanjra, M. A.; Smith, L.; Hussein, M. H.; Bene, C.; Cook, S.; Hirsch, D.; Polak, P.; Valee, Domitille; van Koppen, Barbara. 2007. Reversing the flow: Agricultural water management pathways for poverty reduction. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.149-191.

5.Chandrapatya, Suraphol; Sothearoath, Oeur; Sophorn, Chov. 2007. A guide to participatory rural appraisal for irrigation management and development. Phnom Penh, Cambodia: Ministry of Water Resources and Meteorology (MOWRAM); IWMI Cambodia Office; Belgian Technical Cooperation (BTC) 129p.

6.de Fraiture, Charlotte; Wichelns, D.; Rockstrom, J.; Kemp-Benedict, E.; Eriyagama, Nishadi; Gordon, L. J.; Hanjra, M. A.; Hoogeveen, J.; Huber-Lee, A.; Karlberg, L. 2007. Looking ahead to 2050: Scenarios of alternative investment approaches. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.91-145.

7.Dugan, P.; Sugunan, V. V.; Welcomme, R. L.; Bene, C.; Brummett, R. E.; Beveridge, M. C. M.; Abban, Kofi; Amerasinghe, Upali; Arthington, A.; Blixt, Marco; Chimatiro, S.; Katiha, P.; King, J.; Kolding, J.; Khoa, Sophie Nguyen; Turpie, J. 2007. Inland fisheries and aquaculture. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.459-483.

8.Falkenmark, M.; Finlayson, Max; Gordon, L. J.; Bennett, E. M.; Chiuta, T. M.; Coates, D.; Ghosh, N.; Gopalakrishnan, M.; de Groot, R. S.; Jacks, G.; Kendy, E.; Oyebande, L.; Moore, M.; Peterson, G. D.; Portuguez, J. M.; Seesink, K.; Tharme, Rebecca; Wasson, R. 2007. Agriculture, water, and ecosystems: Avoiding the costs of going too far. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.233-277.

9.Faures, J. M.; Svendsen, M.; Turral, Hugh; Berkhoff, J.; Bhattarai, M.; Caliz, A. M.; Darghouth, S.; Doukkali, M. R.; El-Kady, M.; Facon, T.; Gopalakrishnan, M.; Groenfeldt, D.; Hoanh, Chu Thai; Hussain, I.; Jamin, J. Y.; Konradsen, F.; Leon, A.; Meinzen-Dick, R.; Miller, K.; Mirza, M.; Ringler, C.; Schipper, L.; Senzanje, A.; Tadesse, G.; Tharme, Rebecca; van Hofwegen, P.; Wahaj, R.; Varela-Ortega, C.; Yoder, R.; Zhanyi, G. 2007. Reinventing irrigation. In Molden, David (Ed.). Water for food, water for life: A Comprehensive Assessment of Water Management in Agriculture. London, UK: Earthscan; Colombo, Sri Lanka: IWMI. pp.353-394.