TECHNICAL FOCUS PAPER

Water and food security – Experiences in India and China

www.gwp.org

Global Water Partnership

Global Water Partnership (GWP), established in 1996, is an international network open to all organisations involved in water resources management: developed and developing country government institutions, agencies of the United Nations, bi- and multilateral development banks, professional associations, research institutions, non-governmental organisations, and the private sector. GWP was created to foster Integrated Water Resources Management (IWRM), which aims to ensure the co-ordinated development and management of water, land, and related resources by maximising economic and social welfare without compromising the sustainability of vital environmental systems.

GWP promotes IWRM by creating fora at global, regional and national levels, designed to support stakeholders in the practical implementation of IWRM. The Partnership's governance includes the Technical Committee (TEC), a group of internationally recognised professionals and scientists skilled in the different aspects of water management. This committee, whose members come from different regions of the world, provides technical support and advice to the other governance arms and to the Partnership as a whole. The Technical Committee has been charged with developing an analytical framework of the water sector and proposing actions that will promote sustainable water resources management. The Technical Committee maintains an open channel with the GWP Regional Water Partnerships (RWPs) around the world to facilitate application of IWRM regionally and nationally.

Worldwide adoption and application of IWRM requires changing the way business is conducted by the international water resources community, particularly the way investments are made. To effect changes of this nature and scope, new ways to address the global, regional and conceptual aspects and agendas of implementing actions are required.

A **Technical Focus Paper** is a publication of the GWP Technical Committee aimed at harnessing and sharing knowledge and experiences generated by Knowledge Partners and Regional/Country Water Partnerships through the GWP Knowledge Chain.

ISSN: 2001-4023
ISBN: 978-91-85321-95-7

Printed by Ljungbergs
Design and layout by Scriptoria, www.scriptoria.co.uk

MILJÖMÄRKT 341 116 TRYCKERI

Contents

Acronyms

AMIS .... Agricultural Market Information Services
CAD .... Command area development
CCICED .... China Council for International Cooperation on Environment and Development
CRIDA .... Central Research Institute for Dryland Agriculture, India
FAO .... Food and Agriculture Organization of the United Nations
GWP .... Global Water Partnership
ICAR .... Indian Council for Agricultural Research
IFAD .... International Fund for Agricultural Development
IPC .... Irrigation potential created
IPU .... Irrigation potential utilised
ICRISAT .... International Crops Research Institute for the Semi-Arid Tropics
IWMI .... International Water Management Institute
IWRM .... Integrated water resources management
LDCs .... Least developed countries
MMI .... Major and medium irrigation
OECD .... Organisation for Economic Co-operation and Development
PES .... Payment for environmental services
SDGs .... Sustainable development goals
TFP .... Total factor productivity
WFP .... World Food Program
WMAs .... Water management areas
WUAs .... Water user associations
WWAP .... World Water Assessment Program

Foreword

Droughts, floods, rising food and energy prices, and population growth have all served to focus the world's attention on water security and particularly the vital contribution that water makes to securing the world's food supplies. Future predictions suggest that the gap between water supply and demand is now growing and will be as much as 20 percent by 2030. This will be most acute in water scarce countries, unless there is investment to make better use of existing supplies and develop new resources.

This paper argues that the coming battle for global water, food, and energy security will most likely be won or lost in Asia. This is a region that relies very much on irrigation for food production and where already two thirds of the world's 850 million poor and hungry live. India and China dominate the region in almost every aspect – in population, economic importance, and growth. So what happens in these countries will no doubt impact the whole region. Both are described as mega-countries with high population densities, near double digit economic growth, and populations exceeding 1 billion people. But here the similarity ends as each country approaches the governance of water management and food production in quite different ways, which very much mirror their contrasting political systems. The author, who has an intimate knowledge of both the history and current development strategies being adopted in each country, compares and contrasts the ways in which they are tackling the same challenge of harnessing water resources under growing water scarcity and competing demand. This analysis offers fascinating insights for others who are developing agriculture and water policies and raises issues about the appropriate balance between central authority and decentralised water management.

I am grateful to the author, Uma Lele, who is a member of GWP's Technical Committee, for her most stimulating and thought-provoking paper. I would also like to acknowledge Tushaar Shah, Gao Zhanyi, Jikun Haung, Amnon Golan, Michael Cernea, Khalid Mohtadullah, Michael Muller, Aditi Mukherjee, Thierry Facon, G. Shi, Claudia Sadoff, N.C. Saxena, Prabhakar Tamboli, and Sampath Thirumangalam who contributed to this paper through stimulating discussions and generously sharing their work. Thank you also to the members of the GWP Technical Committee for their invaluable comments and suggestions; to Sambuddha Goswami and Maggie Klousia for research assistance; to Melvyn Kay for editorial support.

I am deeply appreciative of the advice and support provided by Dr Ania Grobicki, GWP's Executive Secretary.

Dr Mohamed Ait-Kadi
Chair of GWP Technical Committee

Executive summary

The twin challenges of accessing water and energy for food and agriculture are central to reducing poverty and hunger in Asia. Despite the green revolution's success, the continent is home to two thirds of the world's poor and hungry. Investments in the 1970s and 1980s in irrigation and energy have fuelled agricultural revolutions throughout much of Asia and increased employment and incomes. But with the near double digit economic growth, Asia has also experienced increasing inequality, the world's highest population densities, and growing competition for limited land and water resources. The 2030 Water Resources Group, an alliance of private sector organisations, concluded that historic rates of supply expansion and efficiency improvement will only close 20 percent of the supply–demand gap. The Group argues that the future 'water gap' can be closed if water scarce countries boost efficiency, augment supply, or reduce the water-intensity of their economies by ranking alternative investments in terms of their benefits and costs.

But water and food security pose a 'wicked challenge'. A complex mix of hydrology, engineering, constitutional, legal, political, social, inter-sector, institutional, and agronomic issues – with a mix of vested interests – drive policy and determine outcomes in each country. As yet there are few examples of well-documented sustainably managed land and water systems even after nearly 20 years of global acceptance of the Dublin principles (ICWE, 1992).

Water and land related conflicts are increasing within and across national borders. Economic growth will likely exacerbate these conflicts. Defence and security experts warn that such conflicts pose the biggest threat to regional peace and security in Asia in the twenty-first century.

There is a renewed urgency to understand the determinants and dynamics of water demand, given climate change and demographic pressures, and the challenges that governance poses for harnessing water resources for their effective, equitable, and sustainable use. To further the debate and analysis, this paper identifies important strategic issues confronting the governance of agricultural water management in Asia and its integral relationship with energy management in irrigated and rainfed agriculture. This paper focuses on India and China as dominant and influential countries in the region. Comparisons between these two mega-countries have fascinated analysts for decades as they have each attempted to address similar issues under very different political systems. This interest has increased even more. Their populations now exceed 1 billion each, and together constitute nearly a third of the global population. And until the advent of the global recession they were experiencing near double digit growth. This paper compares and contrasts the ways in which these countries are tackling the same challenge of harnessing water resources to increase effectiveness, equity, and sustainability under conditions of growing water scarcity and competing demands.

Effective water management is a more complex challenge in democratic and decentralised countries, such as India. Here there are competing interests at the political, administrative, and basin levels and less central control than in unitary centrist states, such as China. The differences range from their constitutions to local management. According to the Chinese constitution, ownership of land, water, and other natural resources is vested in the nation state. In a federated India, ownership and user rights, as well as responsibility for the management of water, agriculture, and forests, is largely vested in the hands of the governments of the 28 states and seven union territories. The role of the central government is limited to transboundary issues between states or across national boundaries.

Each country offers useful insights into developing agriculture and water policies and raises issues about the appropriate balance between the exercise of central authority and decentralised management. Yet solutions are not easily transferable across countries and continents, e.g. between China and India, or between Asia and sub-Saharan Africa, which also faces severe water and food security challenges. In the words of Douglas North, the Nobel Prize winning economist, "*the political choices and institutions are path dependent*". Experience in China and India suggests that where governance and community capacity is weak, it is risky to undertake technologically demanding hardware projects. In situations of weak governance and institutional capacity, effective small-scale water management solutions are necessary, but are unlikely to be sufficient in the face of growing intra-country and inter-country transboundary competition, impending threats of climate change, and differential state capacities for collective action. Three areas are in need of urgent attention:

- Better, more reliable and transparent information on the rapidly changing nature of hydrological, demographic, and socioeconomic pressures at all levels, and an understanding of their complex and changing interactions;
- Empirically based, methodologically sound analyses of the realities on the ground as an essential input into developing normative policy prescriptions, including integrated water resources management (IWRM) approaches; and
- Awareness raising, information, and advocacy campaigns among people and decision-makers at all levels to develop consensus on the magnitude of the water challenge and the urgency to act on it. This is an essential ingredient for developing solutions that are effectively implemented and independently assessed on a routine basis to determine their impacts and refine solutions.

1 Water and food are global priorities

The governance and management of water and food must be seen in the context of an evolving articulation of the challenges they pose locally, regionally, and globally, separately and together.

The latest UN World Water Development Report, bi-annually published by an alliance of 28 UN Agencies (WWAP, 2012), urged that water be the priority item on the 2012 Rio+20 agenda. The report summarised the challenges posed by the increasing demand for freshwater as a cross-cutting issue, central to all development, with multiple management challenges. It called for coherent leadership, better freshwater information gathering and sharing, and better systems for measuring and controlling water at local, national, and global levels. It stressed the need for governments, the private sector, and civil society to work closely together and integrate water as an intrinsic part of their decision-making. The 2012 Rio+20 conference proposed to set a roadmap for the twenty-first century and a new direction for the sustainable use and management of the world's freshwater resources. While the outcomes were less than needed to meet the challenge, there was a growing consensus to move from the Millennium Development Goals to the more inclusive Sustainable Development Goals (SDGs). If adopted, SDGs will have far reaching implications for including and measuring changes in natural capital in the course of economic development. Previously, conserving natural capital was largely an environmental objective. The short- and long-run costs, benefits, and negative and positive externalities/ spillovers and the trade-offs and conflicts that conservation often brings in the real world, as seen by the various stakeholders, were not fully explored.

Since 2007, rising global food prices have similarly brought food security back onto the global agenda, raising both short- and long-term challenges. In the short and medium run, increased use of land and agricultural commodities for biofuel production, facilitated by subsidies from the Organisation for Economic Co-operation and Development (OECD) countries, has become a subject of intense policy and analytical debates (Bobenrieth et al., 2012; Hertel, 2010; Wright, 2011). Analysts have concluded that low grain stocks combined with the impacts of the biofuel policies of major grain exporting countries, which divert grain away from food to biofuels, explain the rise and volatility in world market prices. The price rise in turn triggered export bans by major rice exporting countries. These various factors have increased the world's attention to food, energy, agricultural trade, and subsidy issues. The G20 meeting in June 2011 led to the establishment of the Agricultural Market Information Services (AMIS) as a way to increase transparency and enable global markets to function better through improved market information on prices and supplies. This was a low-hanging fruit and was followed by a focus on productivity growth at the next G20. That initiative came after years of neglect in investments in agricultural R&D. AMIS focuses on four commodities – wheat, maize, rice, and soybeans – and the key players in these markets. It intends to provide reliable, up-to-date information on supply and production forecasts, demand, stocks, and export availability. AMIS is also meant to be an early-warning mechanism for global food markets, allowing them to prepare in advance to respond to price volatility and ultimately coordinate policy responses (Schmidhuber, 2012).

In the face of the food crisis, the OECD/FAO (Food and Agriculture Organization of the United Nations) reassessed their long-term supply and demand projections for 2050 (OECD/FAO, 2012). They concluded that the world will be able to feed a population of 9 billion much as it did when the world successfully dealt with the global population increases from 1 to 2 billion and then to 7 billion during the past eight decades. Barring biofuels, the greatest potential lies in "*increasing productivity on existing lands using known technologies and further expanding the technological frontier by investing in agricultural research and development*". To achieve this, food and agriculture must remain centre stage and will need to address the many complex challenges of climate change, natural resource degradation, and policy and institutional reform. But the impacts of biofuels and environmental policies, such as payments for environmental services, remain wild cards for long-run food security (Bobenrieth et al., 2012; Wright, 2011; Hertel, 2010). Future energy prices and policies will critically determine land use changes as the two have already begun to move more in tandem (Lele et al., in print).

The food crisis has also increased the popularity of 'foresight' exercises – at least 40 have already been conducted by different actors. They question the reductionist, deterministic future projections – albeit as yet without much clarity or consensus on the 'foresight' concept or the methodologies to achieve it (Bourgeois, 2012). Although there are a few exceptions, many lack solid frameworks, data, and probabilistic analysis.

Following the growing uncertainty of prices and supplies in international markets, the idea of food self-sufficiency is gaining popularity in the national policies of developing countries. It is perceived as a way to stabilise domestic prices and supplies and avoid the street riots which were endemic in 2007 and 2008. The relationship between food prices and political stability is beginning to receive attention in unexpected quarters (Arezki and Brückner, 2011).

Concurrently, internationally the concept of food security is slowly shifting from stable *national* supplies and prices to *household and individual* food security. This change has shifted thinking from concerns about average calorie intake across a nation to the individual's access to nutritious healthy foods, including micro-nutrients. Concerns about the interrelated causes of food insecurity – poor sanitation, waterborne diarrhoeal diseases, acute child undernourishment, and health outcomes among children – are also gaining ground. Drinking water pollution from agricultural and industrial chemical runoff is receiving more attention as it affects water and food security. However, devising coherent policies and particularly assuring their effective implementation poses challenges because of the cylindrical, piped nature of government ministries and the far too often absence of holistic approaches among experts.

The critical role of gender in food security is also increasingly being recognised, particularly the broader issues of women's rights and access to resources (including land and water), which influence their ability to produce food and ensure household food security (World Bank, 2012; ICAR and APAARI, 2012; FAO, 2011). Similarly, a comprehensive rights-based approach to reducing poverty, vulnerability, and the need to build resilience among the poor, already enshrined in UN declarations, is now being mainstreamed into national policy-making and implementation.

1.1 Food production

About 80 percent of the world's cultivated land is rainfed and produces about 60 percent of global food production. The remaining 20 percent – about 275 million ha – is irrigated and provides 40 percent (UNESCO, 2012).

Globally, irrigated agriculture is by far the main consumer of water accounting for almost 70 percent of all freshwater withdrawals. In OECD countries, agriculture consumes 44 percent of the total water withdrawals, but in BRIC countries (Brazil, Russian Federation, India, and China) it is about 74 percent. In China it is 64 percent and in India it is 87 percent. In the world's least developed countries (LDCs) agriculture consumes more than 90 percent of all water withdrawals (WWAP, 2012).

Water security features strongly in agriculture, particularly in the context of climate change. This largely manifests itself through impacts on hydrological cycles, most noticeably increasing the occurrence of extreme droughts and floods (Sadoff and Muller, 2009). The concept of water security has only recently begun to take hold. It has not yet gone through the international processes of consensus building and several interpretations of water security have acquired currency.

The world economy is increasingly driven, by shifts in diets and food consumption, towards more water intensive products, many of which are linked to over-consumption and obesity. Typical water-use figures are shown in Table 1. Livestock now accounts for 40 percent of the value of global agricultural output, consuming about 2,000–3,000 km^3 of water annually – 45 percent of the global water embedded in food products (CAWMA, 2007). Much of this water comes from rainfed fodder and feed production farming, which has little alternative value. But increasingly, irrigation water which has significant opportunity costs is used. Recent estimates suggest that 13 percent of global water withdrawals are consumed in producing feed, fodder, and pasture for livestock (WWAP, 2012). More generally, the drivers of global supply and demand for food have major implications for water and land use changes in agriculture (Table 2).

Table 1. How much water do we use?

Item	Amount (litre/day)
Drinking water	2-5
Household use	20-150
1 kg rice	3,500
1 kg beef	15,000
Daily diet	1,000 to 5,500 depending on diet and how and where the food is produced

Source: WWAP (2012).
Note: These data are illustrative of water use and amounts vary depending on climate and location. Food and diets include both rainfed and irrigated crops.

Table 2. Drivers of global demand and supply of food

Demand side	Supply side
Population growth (all in LDCs)	Climate change
Income growth (mostly in LDCs)	Limits to land, water, soils, biodiversity, forests, fisheries
Urbanisation	Increased risks and uncertainty
Shift in food preferences (rice, wheat, maize, soybeans to animal feed)	Technologies (off-the-shelf and developed through investment in research and development)
Biofuels (maize, oilseeds)	Policies, institutions, and physical infrastructure
Processed foods with increased use of energy in transport, processing, and storage	

1.2 Water – a complex public good

Like climate change, water, with its changing hydrological cycles, has no boundaries. Water is a particularly difficult natural resource to manage compared with forests or soils. The ambiguous property rights associated with water and the externalities to other downstream users add to the complexity. It involves multiple stakeholders at each level. Increased scarcity and frequent climate related floods and droughts have rapidly transformed water from a natural resource to a commodity, which is subject to active unregulated exploitation and a thriving informal market. Combined with the massive failure of public sector irrigation systems and pervasive downstream anxieties, the urgency of addressing issues of water governance has increased.

Improved water governance calls for an understanding of who are the main players and what are the main drivers. What is the nature of the changing pressure on water? Who sets the agenda and how? What are the new and changing alliances? And how do they affect a natural resource so essential to economic growth, social equity, and a sustainable environment?

Governments tend to have a central, almost monopolistic, role either directly or indirectly in regulating water use. Yet they often have to balance the exercise of authority with an effective mobilisation of all the necessary stakeholders who are key to managing water. Far too often they are either too centrist or too client oriented, without sufficient accountability to prompt water use monitoring and the factors underlying it. Yet this situation is changing rapidly. As water scarcity increases, governments are compelled to seek new, more effective solutions from the experiences of others. Hence there is huge scope to learn lessons from experience.

Past efforts at water management have focused on enhancing supply; investment in irrigation was the primary means to harness water. Irrigation ranges in scale from large river basins spanning several countries to small-scale irrigation in rainfed areas. Irrigation typically spans large geographical areas and several agro-ecosystems. A landscape approach is increasingly promoted as the logical way to plan and implement sustainable development in circumstances of large geographical areas that transcend national boundaries and ecosystems. These areas often encompass human habitats and natural environments, with a mosaic of natural, agricultural, forest, and other land uses unique to the region. A landscape perspective is useful if the goals of biodiversity and ecosystem services maintenance, agricultural production, and improved livelihoods for local people are to be achieved (ANAI et al., 2008). Yet this approach is constrained by political, administrative, policy, institutional, technological, and organisational barriers. A variety of approaches are exploited to harness water supplies at multiple levels, but only in recent times has attention turned to managing demand. Yet the evidence base for demand management is virtually non-existent. Politically, governments have pandered to farmer lobbies demanding free access to water, thus compounding the problem of demand management. Some governments are managing water demand by managing other key inputs, such as pricing the electricity supply for pumping or licensing abstractions from groundwater.

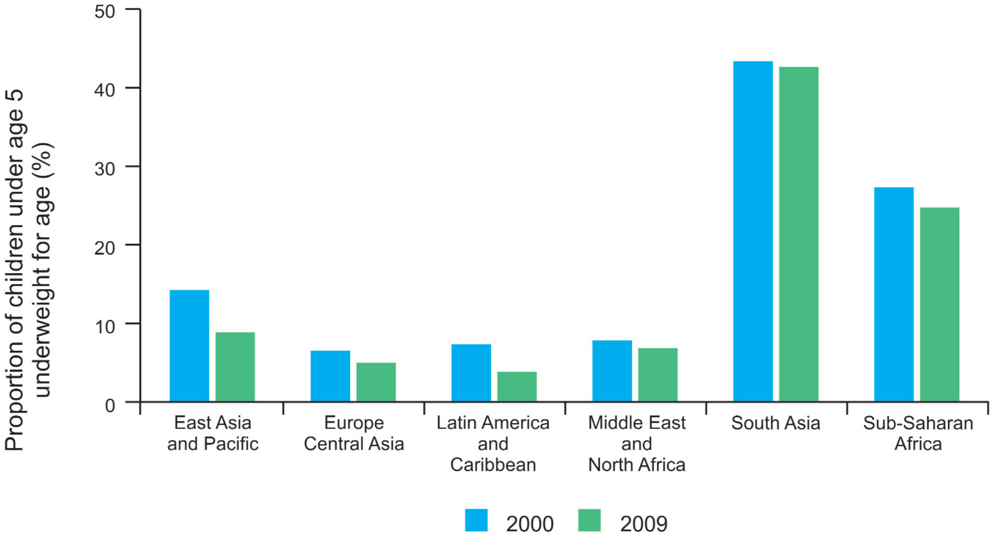
Historically, donors have promoted water pricing as a way to contain water demand; but in the absence of effective public policy and growing water and power scarcity, informal water and energy markets have emerged. With access to new and improved water pumping technology, and the problems of unreliable electricity, farmers in South Asia, for example, are investing in large diesel pumps to meet their water needs. In urban areas consumers are paying for water in informal markets. There are only a few empirical studies of productive, equitable, and sustainably managed land and water systems in the developing world. This paper provides a few examples of the consequences of water and electricity pricing, and related regulations on agricultural intensification (or lack thereof) in India and China. More generally, it demonstrates how food and water security issues are integrally related in Asia. The paper also offers a brief discussion of the lessons that can be learnt from the food and water policies in South Africa and Morocco.

1.3 Asia and Africa are the battlegrounds

Asia and Africa are the future battlegrounds for food, water, and energy security as they face a huge gap between people's resource needs and the available supply. Globally, 850 million people suffer hunger and abject poverty; two thirds live in Asia and a third in Africa, principally in sub-Saharan Africa (SSA) (FAO et al., 2012). Water issues in Asia and Africa are very different. Asia has traditionally relied on irrigation to increase agricultural productivity though rainfed farming, but now groundwater development has begun to gather increasing attention (Foster, 2011; Shah, undated). In contrast most SSA farmers practise rainfed agriculture, but interest in irrigation, although in its infancy, is growing. So, are there opportunities to identify areas where there is scope for inter-country and inter-regional learning?

In East[1] and South Asia[2] the number of undernourished people living in poverty has fallen dramatically. In South Asia, the fall is much less pronounced and undernourishment among children under five years old remains high; indeed it is substantially higher than in Africa (Figure 1). Growth in agricultural productivity has played a critical role in reducing hunger and poverty in East and South Asia, but growth has been much slower in South Asia.

Figure 1. Child malnourishment in Asia and Africa



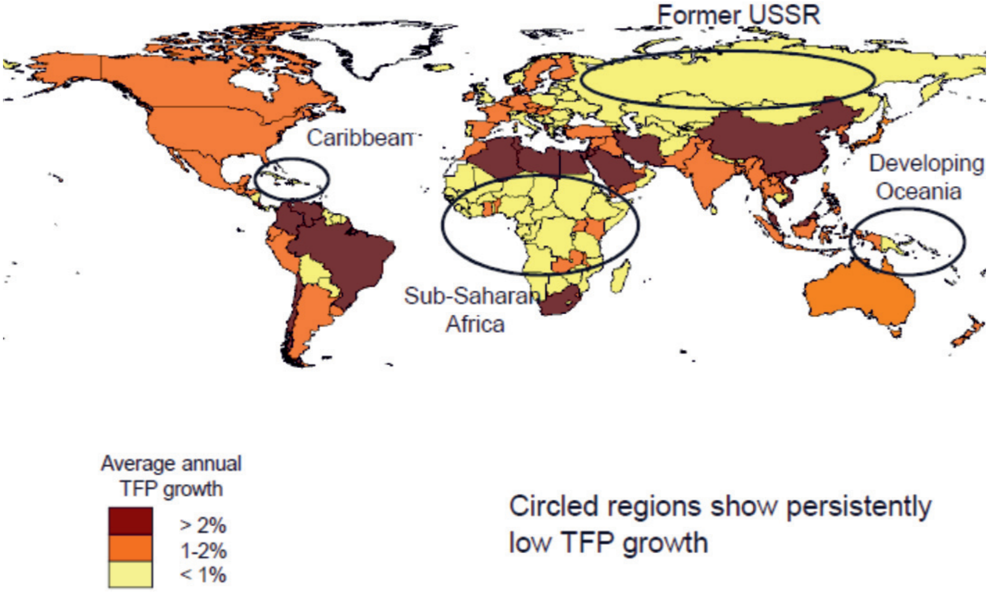
Source: United Nations Children's Fund, World Health Organization, and World Development Indicators (World Bank).

[1] East Asia – China, Democratic People's Republic of Korea, Japan, Mongolia, and Republic of Korea
[2] South Asia – Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka

2 India and China – similarities and contrasts

China dominates in East Asia and India dominates in South Asia in terms of population, economic importance, and growth and so regional trends tend to follow those of the dominant countries (Lele et al., 2011). Comparisons between India and China have fascinated analysts for decades. They are both mega-countries with populations of more than 1 billion people and high population densities. Until the advent of the global recession they were experiencing near double digit economic growth. They each attempt to address similar issues, but under two quite different political systems. These systems are mirrored in their approaches to the governance of their food and water management. The result is significant differences in agricultural total factor productivity (TFP) growth between the countries and their respective regions (Figure 2) (Lele et al., 2011).

Figure 2. Long-run average agricultural total factor productivity growth (1971–2008) (percent per year)



Source: Fuglie (2012).

The TFP growth variations reflect the stark differences in land productivity. India and China have similar areas under cultivation and irrigation and both countries are heavily dependent on cereals. But China's cereal production has increased five-fold over the past 30 years from a land area similar to that of India whereas India has only slightly more than doubled production (Figure 3). There are also marked differences in per capita food availability between the two countries against a backdrop of Africa and the USA (Figure 4).

Figure 3. Total area harvested and total yields for cereals (1961–2010) in China, India, and Indonesia

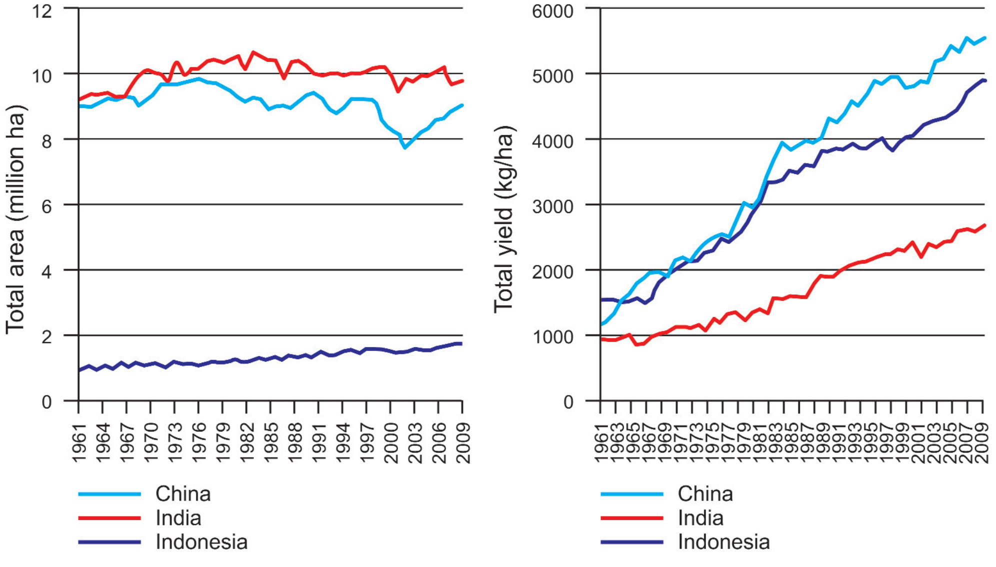
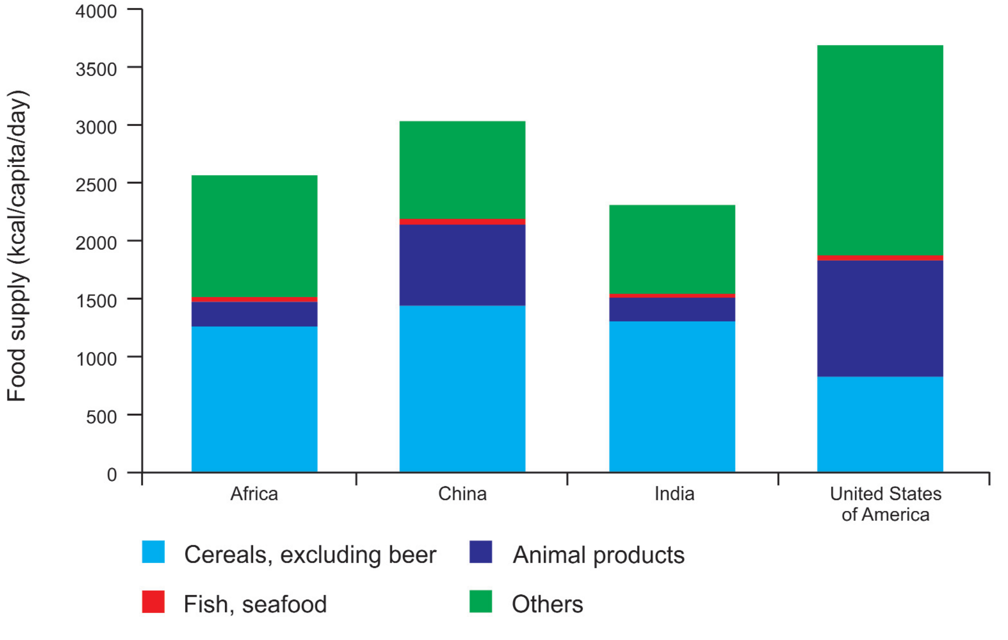


Figure 4. Total food supply (kcal/capita/day) 2009



Source: FAO (2012).

2.1 Food consumption

In India per capita caloric availability is much lower than in China. Contributing factors include India's higher population growth, slower income growth, and slower agricultural productivity growth. Smallholder agriculture has also created less direct and indirect employment, explaining in part the prevalence of child undernourishment in India (Figure 1). Another factor is the differences in consumption of livestock products. India's shift towards livestock products is slower because of the widespread vegetarian diet. To complicate matters further, unlike most other countries, income growth has not always been associated with increased caloric consumption, even among the middle income, urban groups – the so-called 'Indian enigma'. But as both China and, to a lesser extent, India shift toward more water consuming diets, the demand for water in agriculture will inevitably increase. In the Punjab, for example, the area dedicated to cereals has increased from 50 to 75 percent mostly to produce rice rather than wheat. Rice consumes much more water (12,373 m^3/ha) than wheat (3,661 m^3/ha) (Mukherji et al., 2011).

China addressed the challenge of a growing demand by slowing down population growth – its 'one-child' population policy. Additionally, it invested in women's education, increasing the productivity of water, diversifying crop production out of cereals to less water consuming crops, and relying more on food imports as a share of total food availability. An example is soybean imports for the livestock intensification strategy.

2.2 Investment

Much of Asia's policy and investment focuses on harnessing water for food. About 75 percent of the world's cultivated land equipped for irrigation is in Asia, about one third is in East and South-East Asia, and one third in South Asia. About 40 percent of Asia's cultivated land is irrigated (UNESCO, 2008). In 2009, China and India each had nearly 20 percent of the global area under irrigation – 64 million ha in China and 66 million ha in India (Aquastat–FAO, 2012a).

China has invested much more in agriculture than India (Table 3). The investment has been in high yielding cereal varieties, irrigation, power, fertilisers, and other inputs, all made possible by aggressive research and development. This is reflected in the larger number of agricultural patents and new technologies in China. China has also invested more in smallholder agriculture. Indirectly, the rapid growth in agricultural productivity has led to the growth of rural services and manufacturing.

China has invested substantially to increase and protect water supplies by modernising irrigation systems. It has adopted advanced water management policies, institutions, and technologies. And more recently it has increased watershed protection in nested approaches ranging in scale from the transboundary, to the national, and farm levels. China is also purchasing land and groundwater rights in neighbouring countries, such as Japan (Humber, Kuwako and Inajima, 2012). In short, both supply and demand management are important tools in China's water policy, each to a greater extent than in India.

China's high rate of productivity growth can be attributed to irrigation and the opportunity this created to engage in multiple cropping. Hybrid seed technology plays a part, but growth would not have been possible without irrigation.

Table 3. Growth of agricultural outputs and inputs

1961–2009	Average annual output growth (%)	Average annual input growth (%)	Average annual TFP growth (%)
China	4.36	2.3	2.0
India	2.8	1.6	1.0

Source: Fuglie (2012).

2.3 Land availability

India's population will reach 1.52 billion by 2040, exceeding China's projected population of 1.45 billion. India has only one third of China's surface area, although China contains large areas of pasture, grasslands, and deserts where agricultural production is not possible. Demographic pressures have dramatically reduced per capita cropped land in both countries. In China this fell from 0.15 ha/capita in 1961 to 0.09 ha/capita in 2009. In India, over a similar period, it fell from 0.35 ha/capita to 0.14 ha/capita.

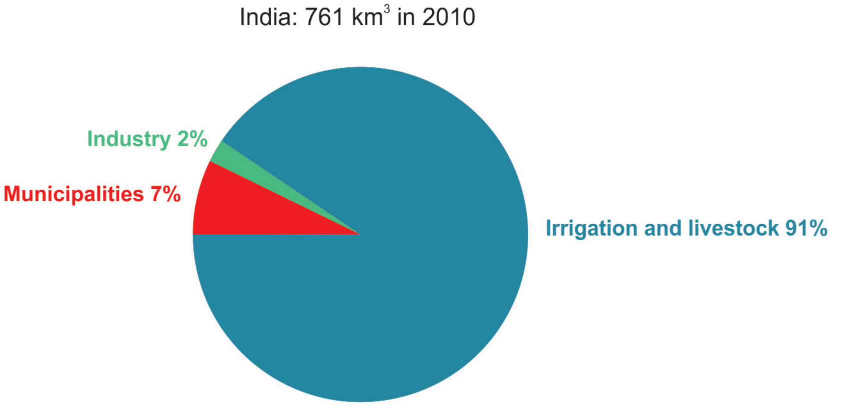
2.4 Water resources and use

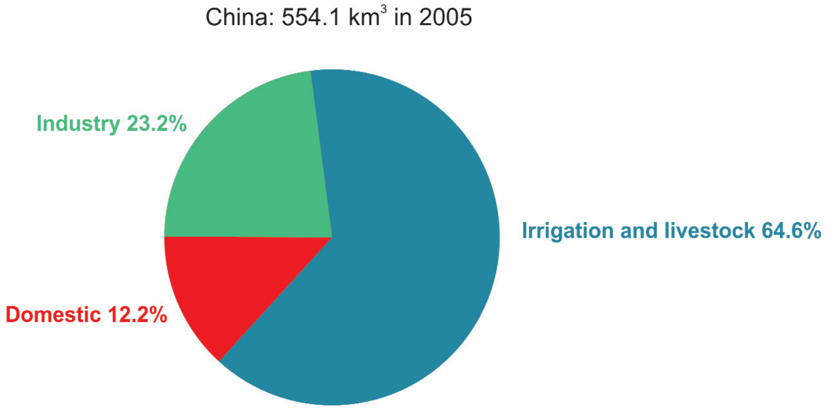
India (13 percent) and China (12 percent) together use about a quarter of the 4,000 km^3 of water withdrawn globally each year (Gilbert, 2012). In India, 87 percent of all reported water withdrawals are for agriculture, only 2 percent is for industry, and 7 percent for municipalities. But by the government's own account, hydrological knowledge is so limited and out of date that it is unclear if this represents an accurate picture of water use. In contrast, China has a far more diversified water sector. Only 65 percent of water withdrawals are for agriculture, 23 percent for industry, and 12 percent for the domestic sector, and there is better knowledge of hydrological resources (Figure 5).

Surface water dominates in China and groundwater in India. Surface water was crucial for irrigation in India until the 1960s. Then the failure of the traditional command and control irrigation systems fed from major rivers as a result of governance failure in the water sector led to smallholders exploiting groundwater (Figure 6). Since 2000, groundwater irrigation is now the dominant resource used for irrigation.

Globally, groundwater abstraction has tripled in the past 50 years and is now an important part of the food and water security story. Groundwater abstraction has increased in China, USA, and Mexico. But India and South Asia have seen the largest growth and have the highest share (nearly 25 percent) of global groundwater abstraction (GWP, 2012a). It has increased ten-fold from 25 km^3 in 1950 to 250 km^3 in 2010. Groundwater now serves about half the irrigated area in South Asia (Table 4). In many countries over exploitation is becoming a major issue.

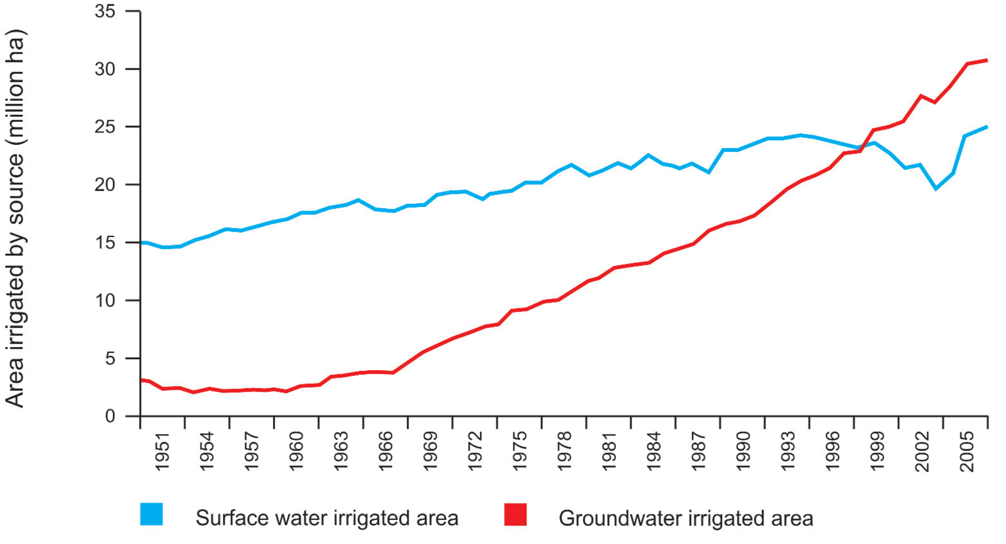
Figure 5. Water withdrawals by sector: India and China





Source: AQUASTAT–FAO (2012b).

Figure 6. Growth of surface and groundwater irrigation in India (1951–2007)



Source: Faures and Mukherji (2011).

Table 4. Groundwater use as share of total irrigation (2008)

Region	Area equipped for irrigation ('000 ha)	Area irrigated by groundwater ('000 ha)	Fraction irrigated by groundwater (%)
Africa	13,445	2,506	19
Northern Africa	6,340	2,092	33
Sub-Saharan Africa	7,105	414	6
Asia	222,269	80,582	36
Western Asia	23,347	10,838	46
Central Asia	23,347	1,149	8
South Asia	93,140	48,293	52
East Asia	68,491	19,331	28
South-East Asia	22,773	971	4
World	304,405	112,936	37

Source: WWAP (2012).

In India, groundwater supplies about 60 percent of the irrigated land and over 80 percent of the rural and urban water supply. A statement from the Ministry of Forests and Environment (Economic & Political Weekly, 2012) declared that unchecked aquifer depletion led to a public health crisis across the country and left agriculture precariously in the balance in several states. Already, almost a third of the groundwater aquifers are approaching and going beyond their sustainable yields. By 2025, it is estimated that about 60 percent of groundwater could be over-exploited.

In contrast to groundwater, India's surface water storage capacity is low at only 190 m^3 per capita. This is less than a tenth of China's capacity of 2,486 m^3 per capita. In comparison the USA has 5,961 m^3 per capita) (Government of India, 2011). These differences are all the more striking given that India, like the rest of South Asia, will be highly vulnerable to climate change, with melting glaciers, unexpected changes in river flows, increased temperatures, more unpredictable rainfall patterns, and increased incidences of floods and droughts, which are already evident.

India's 12th five-year plan gives equal weight to both irrigated and rainfed agriculture – the strategy of 'walking on two legs'. This shift has geographic implications. Normally, the western states of Punjab, Haryana, and (Western) Uttar Pradesh rely on canal irrigation and are the granaries of India. The new strategy entails 'moving to the east' to the well-watered eastern states of Bihar, West Bengal, and Orissa where the priority is rainfed agriculture. This has long been a stated goal of the government. But implementing this move is a major challenge given the 'stickiness' of past policies on price and power subsidies and the interventions and poor governance in the eastern states. But political changes in some states, such as Bihar, Orissa, Chhattisgarh, and Madhya Pradesh, offer the hope of a positive domino effect in the rest of India.

2.5 Transboundary stresses

Water stress is set to become Asia's defining crisis of the twenty-first century. It will create obstacles to continued rapid economic growth, stoke inter-state tensions over shared resources, exacerbate long-time territorial disputes, and impose further hardships on the poor. Many of Asia's water resources cross national boundaries, and international tensions are rising as competition for water increases (Chellaney, 2011). India already has separate treaties, agreements, and memoranda on sharing river water with Nepal (Ganges), Bhutan (Brahmaputra), and Pakistan (Indus).

Lower riparian anxieties and transboundary issues abound in Asia (Wouters, 2012). There are concerns about China diverting Brahmaputra water to northern China via Tibet, and China's claims on part of the state of Arunachal Pradesh are driven by water issues, though China denies this (Chellaney, 2011). There are tensions between Pakistan and India over Indus water, between Bangladesh and India over the Farakka barrage, and between Nepal and India on the Mahakali Treaty and Panchewar project. Bhutan is the only country with a good working relationship with India. They have a power sharing agreement, with half of Bhutan's GDP coming from the sale of hydro-power to India. A long-standing effort to negotiate a similar agreement with Nepal has failed. Nepalese policy-makers see their hydro-power as being similar to oil, and yet they have eschewed dependence on India (Gyawali, 2011). Some water experts question the merits of the large dams favoured by policy-makers (Sadoff and Rao, 2011).

Most water-related tensions concern water scarcity, floods, and other environmental and humanitarian concerns (Khalequzzaman, 1993). There are concerns about India's impact on neighbouring countries and China's impact on India and its neighbours. Smaller countries, such as Bhutan and Nepal, tend to prefer external input in negotiations to increase their bargaining power and transparency. The larger countries prefer bilateral negotiations without external interference. By their very nature, large countries create suspicion in the minds of small countries. The lack of reliable information on water resources and a general unwillingness on the part of governments to share what information does exist, only adds to the distrust and suspicion. Clearly this situation needs to change with functioning bilateral agreements (Iyer, 2011).

Intra-state border conflicts also abound within India and are likely to place the country in a poor negotiating position with its neighbours unless they are sorted out with decisive leadership and collective action. Polarised views around Mullaperiyear Dam have hardened relations between the state governments of Tamil Nadu and Kerala. The states of Andhra Pradesh, Maharashtra, and Karnataka are battling over apportioning Krishna waters (Venot, 2008). Maharashtra and Andhra Pradesh are facing issues over the Babhli villages in Nanded District adjoining Andhra Pradesh. Karnataka, Tamil Nadu, Pondicherry, and Kerala are in conflict over Cauvery. The list is long and the intensity and frequency of these arguments are increasing (Paranjape et al., 2010).

3 Water governance in India

Box 1. What does good governance mean?

The World Economic Forum's Global Competitiveness Report 2002–2003 defined governance as the exercise of authority through formal and informal traditions and institutions for the common good. Thus it encompasses the process of selecting, monitoring, and re-electing governments; the capacity to formulate and implement sound policies and deliver services; and the respect of the citizens and the state for the institutions that govern economic and social interactions among them – the rule of law, protection of property rights, and independence of the judiciary among others.

Fundamental role of institutions

The World Bank (2002) underlined that many of the institutions that support markets are publicly provided. The ability of the state to provide these institutions is therefore an important determinant of how well the provision of such institutions constitutes good governance. That in turn is a result of public perceptions, determined in part by the people's own experience, and their access to information and knowledge and the responsiveness of the governing system to their needs. Certainly, their ability to achieve water security depends on government capability, but the concept of water security itself varies.

GWP (2000) defined water security as ensuring the availability of adequate and reliable water resources of acceptable quality, to underpin water service provision for all social and economic activity. This water service is provided in a manner that is environmentally sustainable; mitigating water-related risks, such as flood, drought, and pollution. It also addresses the conflicts that may arise from disputes over shared waters, especially in situations of growing stress, and turning them into win-win solutions.

3.1 India's 12th five-year plan

In India, constitutionally both water and agriculture are state subjects, unlike in China where the nation state owns water, land, and all other natural resources.

India faces immense competition for water and land. So in June 2012 the Ministry of Water Resources proposed a draft National Water Policy. This complements reports of the Planning Commission's Working Groups on major and medium irrigation (MMI) and command area development (CAD) for the 12th five-year plan. But proposed implementation should be seen in the context of actual implementation experience on the ground. The MMI identified five key challenges critical to food and water security, each of which is a long-standing issue:

- Achieve better use of developed and constructed facilities
- Improve effectiveness of water use in MMI projects
- Ensure the physical and financial sustainability of MMI projects
- Rationalise irrigation service fees and improve their collection ratio
- Incentivise state irrigation agencies to promote participatory irrigation management and volumetric water pricing and delivery to water user associations (WUAs).

The report notes the growing gap between the irrigation potential created (IPC) and irrigation potential utilised (IPU) as an area of major concern. The gap is increasing as a consequence of the:

- Slow pace of CAD works
- Decreases in the number of professional staff in state irrigation agencies
- Paucity of non-plan funds available with irrigation departments resulting in a decline in operations
- Maintenance of MMI projects and the growing amount of maintenance which is in default.

The plan considers closing the IPC–IPU gap by picking the 'low-hanging fruit', such as investing in CAD works and irrigation management reforms. But the history of India's irrigation management does not offer convincing evidence that this will be easily achieved. The CAD Working Group struck a balance between developmental activities, irrigation management reform, capacity building of state irrigation agencies, and the taking up of new projects and improving the speed of rehabilitating existing projects. Improvements in the water resource management information systems of the Central Water Commission/Ministry of Water Resources are also planned as well as establishing monitored targets for 10 million ha through CAD. The collection of irrigation service fees will also increase through WUAs to 50 percent of the total for the irrigation sector. An investment of about US$70 billion is recommended for the MMI sector, of which two thirds will go to the state sector and one third to the central sector.

Concurrently, the CAD Working Group report on natural resources and rainfed farming stresses that 60 percent of the total cropped area spread across many different agro-ecological zones is rainfed. This area supports nearly 500 million people, 75 percent of the country's livestock, and is home to the largest concentration of poverty and under-development. The report pleads for a new paradigm which would combine the past focus on watershed management and resource conservation with one which emphasises productivity and growth with natural resource management as its core strategy. The need to promote diverse local production systems is stressed. Also emphasised is a move away from the existing centrally determined approach of single commodity intensification (meaning rice and wheat) to location-specific systems that help build food security using locally adapted foods. This means a significant step away from state subsidised rice-wheat production in the north-western states of Punjab, Haryana, and Western Uttar Pradesh, which has dominated agricultural policy (Lele et al., 2011). Preference should be given to eastern India which has a huge comparative advantage for producing rice, but is largely unexploited (see Box 2).

Box 2. The unholy trinity of energy, water, and grain subsidies

In 1984 the Johl Commission recommended moving away from input and output pricing subsidies for rice and wheat and promoting a more balanced farming system of crop rotations that would restore soil fertility. But changes in state governments and party politics have constrained reforms. In the Punjab, canal irrigation declined. But irrigation using groundwater increased with a consequent increase in energy consumption. In 2010 energy subsidies for agriculture in Punjab reached US$705.4 million. A lack of metering meant that the Punjab State Electricity Board found it difficult to monitor agricultural electricity consumption and they faced mounting losses because the Punjab State government did not pay the subsidies. The quality of electricity supply to farmers has suffered over the years and, as a result, farmers shifted towards diesel pumping. Although there is now better accounting for electricity use, more timely payment transfers by the state government, and farmers actually receive subsidy payments, the issues of distorted policies in Punjab agriculture continue. With guaranteed minimum prices for wheat and rice Punjab farmers are stuck in the rice-wheat farming system (Mukherji et al., 2011).

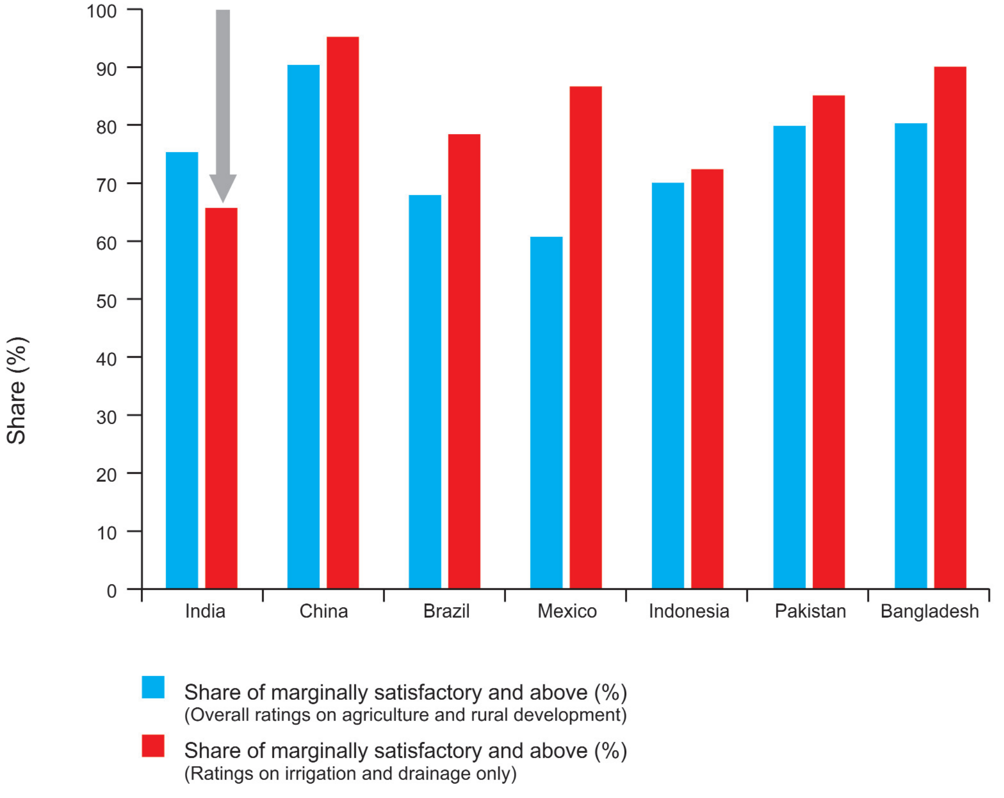
In Karnataka State groundwater irrigation also increased and so did the demand for electrical energy to drive the pumps. But the state is behind Punjab in proper accounting for electricity and payment of subsidies. In 1981 tube wells were de-metered and a flat tariff regime was instituted. This has caused difficulty in accounting, mounting losses for the Karnataka Electricity Board, and a deteriorating quality of supply to farmers over the years. A new body was formed in 2000 to urge improvements in accounting and assessing energy use in agriculture, but the situation is still fraught with problems.

In West Bengal the problem was the reverse. The state denied farmers permits to dig wells even in areas where water was abundant because of a policy adopted by the state government in 2007. A study (Mukherji et al., 2012), brought to the attention of the West Bengal Government by the Planning Commission, indicated that the Ministry of Water Resources of the Government of West Bengal had recently abolished groundwater permits to small and marginal farmers. In one stroke the policy change made it possible for farmers to directly apply for an electricity connection at a flat rate without waiting for a permit from the Ministry of Water Resources.

What seems obvious from these examples is that water and energy policies vary considerably from state to state. In Punjab, policies are driven by farmers accustomed to assured energy subsidies and guaranteed minimum prices for rice and wheat with little accountability to tax payers for how the state performs. In contrast, in West Bengal the state's regulatory policies towards tube well licensing, payments for energy connections, and the lack of a support price for rice, have (until very recently) discouraged rice intensification and productivity growth, even though the declining farm size leaves too little income to make an adequate living out of rice farming (Mukherji et al., 2012).

India's proposed reforms should also be seen in the context of the World Bank's global lending experience for water, which has historically gone almost exclusively to the public sector. The International Finance Corporation has recently increased its assistance to private sector water development. However, without an effective overarching government regulatory framework and its implementation, it could pose the risk of further excessive groundwater exploitation as well as the water needs of the poor being ignored. Since 1950 the World Bank has lent US$23 billion to South Asian agriculture in the form of 567 lending operations for 269 agricultural projects in India. Of these projects, 83 were for irrigation and drainage. India's irrigation projects received lower ratings – only 66 percent compared to the 76 percent average performance for all projects (Figure 7). Irrigation and drainage projects in the other six largest recipients of World Bank loans and credits for irrigation and drainage performed much better than the average ratings for agricultural projects. In India they performed poorly.[i]

Figure 7. Share of 'Marginally satisfactory and above' rankings of the World Bank's top seven irrigation borrowers (1972–2011)

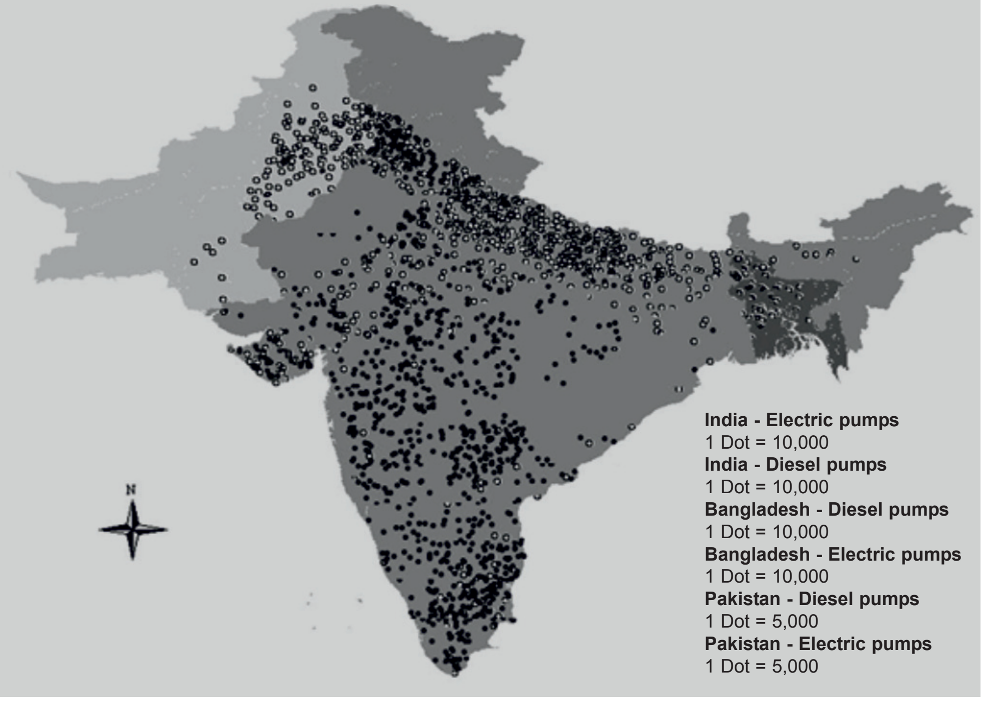


Source: Independent Evaluation Group (2013). World Bank performance ratings. Available at http://ieg.worldbankgroup.org/content/ieg/en/home/ratings.html
Note: The category 'Marginally satisfactory and above' includes Highly satisfactory, Satisfactory and Marginally satisfactory.

Box 3. A tube well revolution

Indian irrigated agriculture has experienced a significant transformation since the 1970s (Shah and Lele, 2011). Millions of privately owned wells and tube wells have emerged as the mainstay of smallholder agriculture (Figure 8). Without them there would have been far greater poverty, deprivation, and social conflict. Whereas groundwater irrigation is not unique to South Asia, the underlying drivers are fundamentally different. Groundwater irrigation has boomed largely as a result of the government's failure to operate and maintain the established large command and control systems of dams and large-scale canal irrigation systems introduced by the British colonial government. Many millions of smallholders now pump shallow groundwater to irrigate their crops. But population pressure on farmland and unchecked abstraction has grown and smallholders have become locked into unviable agriculture based on pumps, wells, and flexible pipes – water abstraction mechanisms (WAMs). Shah (undated) calls it 'water scavenging'. The World Bank had anticipated the groundwater exploitation crisis and in 1972 proposed a system of monitoring and evaluation as part of its support to tube well development in Uttar Pradesh. But this was rejected by the government on the grounds that the issue was too sensitive politically for the involvement of an external agency.

Figure 8. Distribution of electric and diesel pump sets for irrigation in South Asia



Source: Shah (2009).

The small pump and tube well revolution, aided by irrigation service markets, has democratised irrigation in South Asia and has alleviated more poverty than most other government programmes. It has significantly improved equity and flexibility. This is in sharp contrast to the problems prevalent in the 'top-down' large public canal irrigation systems which reach less than 10 percent of the region's smallholders.

Shah (undated) argues that irrigation systems thrive when they serve a small number of large customers; there is homogeneous cropping, planting, and irrigation schedules on the entire command (homogeneity, as in rice irrigation systems); there is an authority to enforce operational discipline on users (as in the Gezira scheme in Sudan in its early years and in China today); and irrigators are held captive to an irrigation culture and community (as in traditional hill irrigation systems in Nepal).

Many irrigating regions across the world meet one or more of these preconditions; this was the case in India in both the colonial and pre-colonial eras. But it is argued that post-independence South Asia meets none of the criteria. As a result, and despite sustained investment, large-scale canal irrigation has been losing out to pump irrigation in both relative and absolute terms.

3.2 Changing groundwater laws

The central government also aims to pass a framework law under Article 252 of the Constitution to change groundwater management rules. This can be done with two states being required to pass a similar law before the central initiative. The particular provision helps the central government to make a law that impinges on federal concerns, but does not override state government powers. Once approved by parliament, it is then necessary for the states to align their regulations to be in keeping with the principles of the central law.

The move could potentially radically rewrite the management of groundwater in India, giving communities rights over aquifers instead of restricting these to landowners who can simply drill and exploit the resource. The government believes this would negate the need to alter the constitutional position of 'water' as a state subject, while penal provisions would be placed within the power of the state.

Changes emerging from the Planning Commission proposals envision Panchayati Raj institutions becoming the real-time custodians of the common resource and helping regulate the use of aquifers in their domains. Such a practice is in vogue in some states, like Andhra Pradesh. Implementing a framework law could ensure that other states devolve power. Bringing water into the concurrent list of the constitution is seen by some within government circles as a politically difficult shot with concerns over federalism bound to play a spoiler. The framework law, the government hopes, will leave the powers of the states untouched.

The central government intends to substantially increase financial support to the states to ensure also a clear demarcation of aquifers, which would allow communities to gain information on the volume of water under their control. Indeed, according to Mihir Shah, Member of the Planning Commission responsible for water and a long-time champion of water management, India must "*move beyond the 'complacency of denial mode'... we cannot manage – nor properly budget for – what we do not measure.*" According to Mihir Shah, the basic national water budget for India has been treated as a holy cow ever since the country became independent. Yet mega water development projects worth billions of dollars have been planned and executed using this information. Hydrological data have, according to Mihir Shah, increasingly come into question from independent scholars (Shah and Lele, 2011).

The law would bring the legislation in tune with Supreme Court rulings, including the Public Trust Doctrine, which can end the common law doctrine that has regulated groundwater use since the colonial era. Having been passed in 1882, the Indian Easements Act is more than a century old and is outdated. Together with other regulations, including the various model bills legislated from time to time, the law gives landowners complete rights to draw as much water as they want without liability or responsibility towards neighbouring landowners. Hirashima (2008) stresses an additional growing disjuncture between land prices and land rents, which has its origins in colonial times. The British effectively nationalised land as a way to extract surplus from the peasantry, but gradually allowed private ownership while imposing rents on land owners. These rents have since eroded relative to the rising price of land.

The government has proposed to hold several rounds of consultations with the states, including a meeting of the National Development Council, to ensure there is early buy-in and that the worries of stakeholders are addressed. The role of the media will be critical in educating the public. The legislature and political parties will need to ensure the very sustainability of the development process by keeping water-related conflicts in check, and the judiciary will need to help bring coherence to a long overdue reform. All of these components will be critical to a new, modern legal framework which replaces old colonial laws.

3.3 Growing water quality problems

Over exploitation of groundwater is producing excess fluoride in parts of 267 districts, nitrate levels are beyond permissible levels in 385 districts, arsenic contamination is reported in 53 districts, and high levels of iron are reported in 270 districts. Traces of heavy metals, such as lead, chromium, and cadmium, were found in water in 63 districts; and biological contamination is reported in many water sources across India. What is worse, even in districts where the water is considered 'safe' in terms of quality and availability, there is likely to be contamination in one form or another. Under-investment in drinking water and sanitation puts India among those countries that have not yet met the Millennium Development Goal targets (Table 5). A recent study of 71 Indian cities documents a water and sanitation issue of gigantic scale (Narain, 2012).

Table 5. Access to improved water and sanitation resources: China and India

	Improved water source (% of population with access)		Improved sanitation facilities (% of population with access)	
Country/Year	1990	2010	1990	2010
China	67	91	24	64
India	69	92	18	34

Source: World Bank (undated).

3.4 Decentralised water management

A democratic India is far stronger politically than it was at the time of independence. But India is also becoming highly decentralised, with greater power shifting to the states and local authorities. Constitutionally both agriculture and water are state resources, unlike in China where the government owns all natural resources. This has weakened the authority and the institutions of the Indian polity, and increased the role of civil society and the media through such good developments as the passing of the Right to Information Act. The number of water disputes within and across states has increased, and with the failure of the legislative and the executive branches of government, the judiciary has had to address many of these disputes. Inter-state disputes, including water issues, have existed since independence and delayed World Bank projects even in the 1960s (M. Cernea, personal communication, 2012; Golan, personal communication, 2012). As the central government fails to address them, recourse to courts is common and occasionally the courts revert the responsibility for negotiating disputes to the Prime Minister (Godbole, 2009). Some have argued that India needs a comprehensive legislation for the development of inter-state rivers and river valleys to facilitate inter-state coordination. This could, ensure that the scientific planning of land and water resources is organised in basins/sub-basins in order to achieve a unified perspective on water resources. This approach would also ensure the holistic and balanced development of both catchments and command areas. Such legislation needs to deal with and enable the establishment of basin authorities with appropriate powers to plan, manage, and regulate water resources. Just how power, responsibility, and authority for basin organisations is dealt with vis-à-vis state governments raises political, administrative, legal, and technical challenges.

3.5 Participatory management

In the 1990s the failure of 'top-down' irrigation management and the disenchantment of civil society and donors led to the transfer of irrigation system management to farmers' organisations and the advent of participatory irrigation management of canals and tanks. Although World Bank lending to irrigation declined, together with all agricultural lending, as part of its reform agenda, the Bank continued to promote participatory management in the irrigation sector with loans to various Indian states, but with limited impact. Several comparative studies presented at the GWP Regional Workshop in Colombo confirmed that participatory irrigation management cannot by itself address problems without complementary government action (Facon and Mukherji, 2011; Samad, 2011). Shah (undated) argues that it is unlikely that institutional reforms of the participatory management genre will arrest or reverse the atrophy in public and community managed canal irrigation systems, which reflect the larger failure of the central and state governments.

Perhaps the future lies in the reinvention of the large canal systems, changing them from a technology that delivers gravity-flow to farms to one that can increase the supply of scavenge-able ground and surface water close to farming communities. An important question is whether the new technologies, such as smart phones and tablets, will also enable India to leap-frog into an effective decentralised system of water management, watershed by watershed and agro-ecological zone by agro-ecological zone, as the Planning Commission's Report urges. Will it be rapid enough to keep up with the growing pressures of demography, urbanisation, and climate change?

Box 4. The important role of agricultural research in initiating crop improvements in rainfed areas

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), working with the Indian council of Agricultural Research (ICAR) has improved 35 varieties of sorghum, 80 varieties of pearl millet, 36 varieties of chickpea, 21 varieties of pigeon pea, and 26 varieties of groundnut – all highly nutritious, drought-tolerant crops. They also offer solutions for the sustainable management of rainfed farming systems through integrated watershed management. Improved rainfed management can produce an average of 5.4 tonne of grains/ha/yr which could support 22 persons. But current practice lags well behind this potential with an average production of just 1.1 tonne of grains/ha/yr which supports only five persons. The potential is to increase household incomes from US$133 to US$533. To bridge the yield gaps, a consortium of partners (ICRISAT, the Central Research Institute for Dryland Agriculture a research institute of ICAR, the Government of Andhra Pradesh, the National Remote Sensing Centre, and private companies) developed a participative integrated watershed management model. This is being scaled up in 300 watersheds in 13 states. ICRISAT reports that this has already enhanced the productivity of two million households in Karnataka Bhoochetana. Addressing widespread micro-nutrient deficiencies in the dry land areas of India can lead to crop yield increases of 30–100 percent. A similar programme is being developed for Andhra Pradesh.

Moreover, ICRISAT has returned 44,723 national germplasm accessions to the National Bureau of Plant Genetic Resources, providing 357,204 accessions of its mandate crops to India. Clearly a significant development is the Government of India's prioritisation of dry land farming in its 12th plan beginning April 2012. ICRISAT and ICAR have also agreed to work more closely to make India self-sufficient in groundnut, pigeon pea, chickpea, and coarse cereals using tested science-based innovations. This will all help to extricate vulnerable rained communities from poverty for good (Dar, 2011).

Beyond technology, the development of rainfed areas will require substantial investment in physical infrastructure (Kerr, 1996; Binswanger et al., 1993).

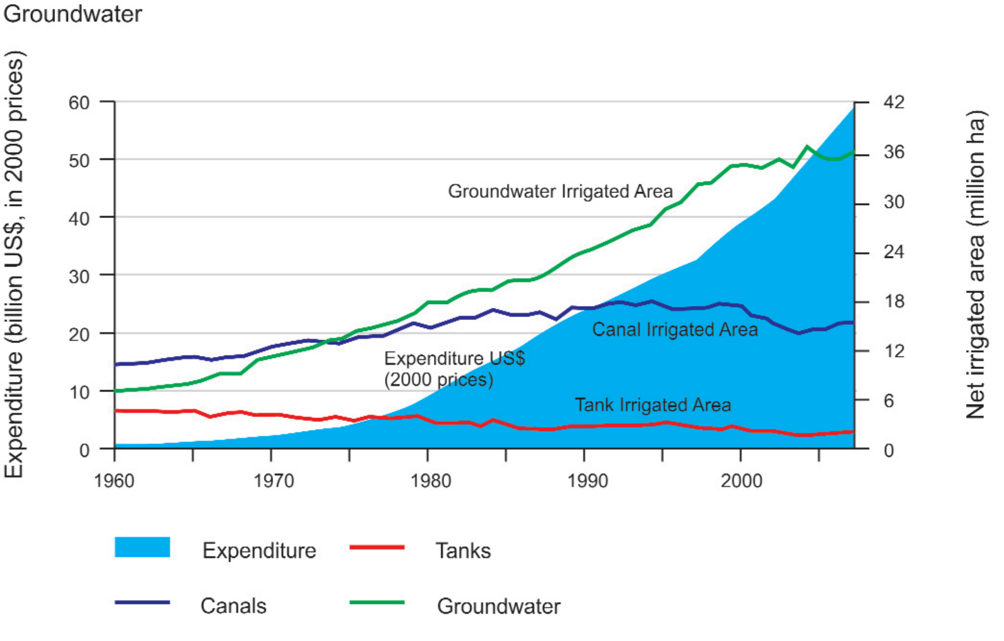
India has shown a remarkable ability to withstand and cope with these pressures, but its implementation record in the public sector and its ability to successfully overcome these challenges through state action is weak. A notable exception is in Gujarat where the state government has consolidated and supported a growing mass movement for rainwater harvesting and groundwater recharge (see Box 4). Farmer communities have constructed over 300,000 recharge structures, such as check dams, percolation ponds, bori-bands, and sub-surface dykes across river beds. This recharge movement is estimated to have increased the state's total water resources by 3–5 percent at a critical time in the growing season. Gujarat also invested US$250 million to electrify villages with exclusive links for tube wells. Farmers were offered a daily ration of eight uninterrupted hours of full voltage power supply on a strictly scheduled roster. This is in contrast to the earlier situation of longer hours with frequent interruptions and variable voltage power at unpredictable times – mostly at night. The result was groundwater recovery, decline in electricity consumption and subsidies, and Gujarat emerging as the fastest growing agricultural economy of all Indian states. Gujarat's annual agricultural GDP grew at 9.6 percent between 2000 and 2008. Shah (2009) argues that the Gujarat experience is a good example of IWRM in practice. Evidence from Pakistan supports the benefits of groundwater irrigation; a cubic meter of groundwater irrigation adds 2.5 times more to Pakistan's GDP than a cubic meter of canal irrigation (Gillani, 2011).

But a lack of holistic action on water governance and the growing informality of groundwater irrigation, with profound changes in the institutions of water management, pose many problems of over exploitation and environmental impacts. Fiscal subsidies to electricity have further compounded the problems.

3.6 'Complacency of denial'

There is a sentiment amongst water experts that India must move beyond the 'complacency of denial' mode about its spending, implementation, and monitoring of water-related activities. Basin-wide knowledge and analytical frameworks to facilitate cooperative planning among riparian states are surprisingly scarce and difficult to obtain. In particular, very little information is available on hydrology and irrigation withdrawals in India (Sadoff and Rao, 2011). Other causes of the deepening water crisis include the reduced effectiveness of MMI systems because of implementation failures, the absence or ineffectiveness of WUAs, the low technical and managerial capacity of irrigation department staff, failure of cost recovery, and failure to expand surface irrigated areas despite substantial investments (Figure 9). The 12th plan proposes steps to deal with these issues.

Figure 9. Irrigation investment and irrigated area in India



Source: IWMI (2009).

Water management solutions prescribed by the World Bank include: economic incentives, such as water charges, taxes, and subsidies; allocation of property rights; direct legal and administrative regulation; participatory aquifer management; and supply augmentation. Shah's research suggests that nowhere is there a regime that has succeeded in taming what he has called the anarchy endemic in groundwater irrigation using these instruments (Shah, 2009; Shah, undated). Consistent with Ostrom's polycentric approach to resource management for India (Ostrom, 2009), Shah (undated) proposes approaches involving specific national, state, district, and local institutions from multiple sectors, i.e. the public sector, private sector, NGOs, farmers organisations, semi-autonomous institutions, and, not least, legal institutions and the media.

Box 5. A 'polycentric approach'

Viewing the performance of South Asia, particularly India, and China from the lens of a 'polycentric approach' is instructive. Ostrom (2009) argues that the polycentric approach "*has the main advantage of encouraging experimental efforts at multiple levels, leading to the development of methods for assessing the benefits and costs of particular strategies adopted in one type of ecosystem compared to results obtained in another ecosystem*". Speaking in the context of climate change, Ostrom noted that building a strong commitment to find ways of reducing individual emissions is an important element for coping with this problem, and "*having others also take responsibility can be more effectively undertaken in small- to medium-scale governance units that are linked together through information networks and monitoring at all levels*". Empirical studies of common-pool resource dilemmas have identified a large number of variables that increase the likelihood of cooperation (Poteet et al., 2010). Among the most important are:

Reliable information available about the immediate and long-term costs and benefits of actions:

- Individuals involved seeing the common resource as important for their own achievements with a long-term time horizon;
- Gaining a reputation for being a trustworthy reciprocator to those involved;
- Individuals involved communicating with at least some of the others involved;
- Informal monitoring and sanctioning is feasible and considered appropriate;
- Social capital and leadership is needed, related to previous successes in solving joint problems;
- When individuals and groups face rules and sanctions imposed by external authorities, they view them as legitimate if enforced equitably on all.

3.7 Canals to recharge aquifers

Proponents of a more decentralised system contend that India's canal systems need to be redesigned to enhance and stabilise groundwater aquifers that offer a water supply close to the points of use, permitting frequent and flexible just-in-time irrigation of diverse crops. In Rajasthan and Gujarat many canal irrigation systems have already created value by unintentionally recharging groundwater irrigation and providing a resource that farmers can exploit by drilling their own tube wells in command areas.

The integration of large canal irrigation projects with the groundwater irrigation economy might necessitate a rethink of India's modernisation plans. Replacing canal-based distribution systems below branch canals with buried pipelines may be a more effective way of using surface storage than canal irrigation. This will also mean building on the growing interest throughout South Asia in pipes rather than open channels to transport water. Buried pipes take up less space, they provide more flexibility than canals, and place less reliance on an already unreliable public delivery system.

3.8 Conjunctive water use

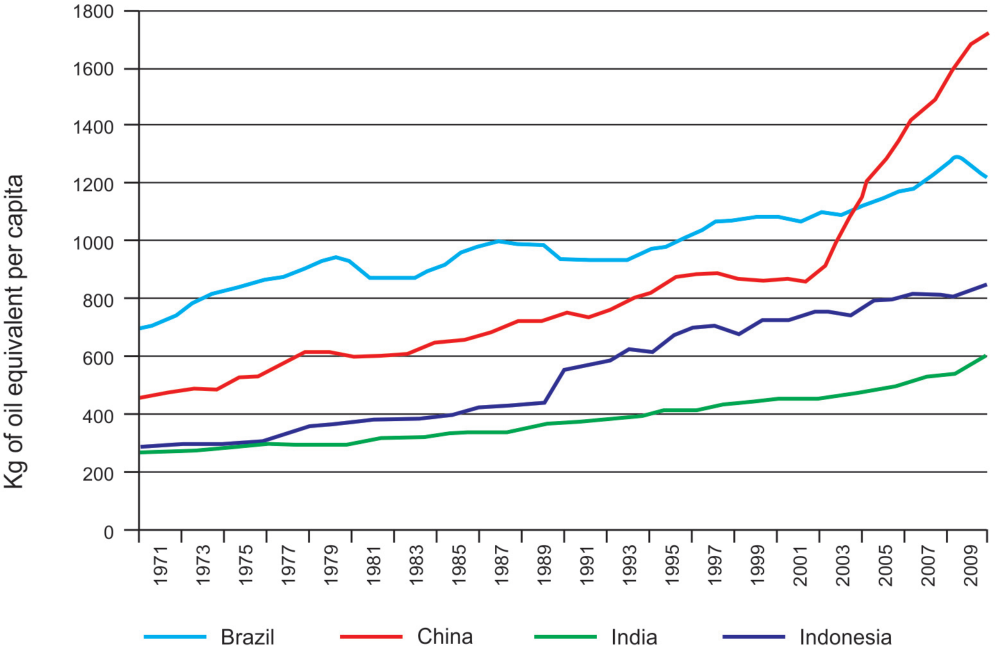
Conjunctive use of rain, surface water, and groundwater will require leadership roles for irrigation, watershed, and rainfed authorities working with other partners at all levels, including NGOs. Mass groundwater recharge will call for reassessment of the roles of the central government water boards, state groundwater departments, NGOs, and water communities. Supporting water transport and distribution by pipes instead of channels will require input from private sector companies working with governments and NGOs. Help will also be needed to support communities coping with negative externalities rather than trying, unrealistically, to eliminate them. This will require a more deliberate, phased approach to groundwater recharge which would then make better use of the nearly US$60 billion already being spent in subsidies of all kinds in the rural sector, such as food, fertilisers, and employment.

The biggest barrier, according to both Tushaar Shah and Mihir Shah, is the region's 'stuck' mindset which is still linked to the colonial past and is dominated by command and duty (sometimes called control). This is thinking in the civil engineering mode and so groundwater, soil, and water conservation are secondary considerations.

3.9 The energy–irrigation nexus

Developing irrigation requires investment in the energy sector for pumping. India has not invested enough in energy to date and so the country is facing a growing gap between supply and demand (Lele et al., 2011). Investment in energy supply is needed as well as making better use of existing resources. This will involve electricity utilities and rural electrification organisations from the national to the local levels. The widely documented Gujarat experiment, with smart rationing of the farm electricity supply to control groundwater withdrawals, as well as electricity subsidies, has shown promising results (Shah, 2009). An important question is the extent to which such comprehensive solutions are appropriate for each state and agro-ecological area. The Maharashtra Groundwater Development and Management Act of 2009 is designed to involve local communities in the management and development of watersheds, inter alia, to increase groundwater recharge in conjunction with the technical expertise provided by the Groundwater Survey and Development Agency. However, elite capture and corruption is a pervasive phenomenon in India's stratified society, including in Maharashtra (Mansuri and Rao, 2012). Many of the reforms have not yet confronted the issue of subsidies for electricity and water that mainly benefit the relatively better-off farmers.

Figure 10. Comparison of energy use in Brazil, China, India and Indonesia (1971–2009)



Source: World Bank. World Development Indicators and Global Development Finance.

3.10 A role for micro-irrigation?

Micro-irrigation on a large scale has the potential to maximise water productivity as well as energy efficiency in groundwater irrigation, but not all crops are suited to such techniques. Micro-irrigation is not a silver bullet. Developing this option will require massive private sector involvement. This involvement will need to take place in a more regulated, non-corrupt environment with a responsible facilitative role for various authorities and financing institutions if the experiences from the recent groundwater and micro-finance crises are not to be repeated (Mahajan and Navin, 2012).

3.11 A strong farmer voice

It is clear from the Indian examples of Punjab and Karnataka, where farmers have a strong voice, that there is considerable pressure to introduce and maintain subsidies. In West Bengal, where smallholders have had relatively little voice, government regulation has constrained their access to water. But in Gujarat, and recently in West Bengal, progressive political and administrative leaders have introduced regulatory reforms to ensure the sustainability of water use while increasing farm productivity. In Punjab there are indications that farmers would be willing to pay energy charges if water supplies could be assured and reliable. Although the Punjab government has not addressed either energy or water subsidies, it has recently announced a decision to promote more maize production as a way to reduce water demand (Mukherji et al., 2011). Gradual withdrawal of the guaranteed minimum producer price policies would also wean farmers away from the destructive rice-wheat crop rotations that have adversely affected soil fertility, raided state coffers, and arrested agricultural diversification.

3.12 India's new reality

India's irrigation economy is vastly different in structure and organisation from that which the British left behind, yet mainstream irrigation policy is still steeped in the colonial mode. Smallholders have now worked out how to mobilise, store, scavenge, and apply water largely outside the main constraints of traditional irrigation thinking and practice. The region's irrigation planners and managers need to come to terms with the new reality, especially as climate change threatens to make irrigation management even more challenging in the future.

4 Water governance in China

4.1 More formal water management

The contrast between water governance in China and India and their development over the past 50 years could not be greater. Constitutionally water and other natural resources are owned by the state in China, unlike in India where individual states have responsibility for water, forests, and agriculture. In India the historical private ownership of farm lands accompanies water ownership. In China, under the 'household responsibility system' introduced in the late 1970s, management decisions were given to farmers. This liberalisation had been preceded by a major land reform in which not only had the state taken control of land ownership, but land access had been equalised. The responsibility system was thus preceded by an equal distribution of land. Major canal irrigation accounts for over 80 percent of China's irrigation, with only 18 percent from shallow groundwater, mostly in the north. China has 532 large water reservoirs and 3,000+ small- and medium-sized reservoirs. Agriculture comprises over 60 percent of the total water use, but this is declining slowly as productivity increases.

China's institutional reforms in the water sector are a logical extension of the 'household responsibility system' introduced into agriculture. Farmers are given long-term leases to public land and decision-making is left to them on matters of agricultural reform and other policies.

China plans to spend US$600 billion revitalising the irrigation sector over the next 10 years (Mohtadullah et al., undated). China's annual investment of $60 billion annually will be greater than the total irrigation investment in India's entire 11th five-year plan. The proposed budget for India's 12th plan for MMI is US$70 billion over five years.

But China's approach to water development goes well beyond infrastructure funding and encompasses major policy, institutional, and organisational reforms. The fact that land and water are state owned resources with state authority vested in their development, allows China the freedom to act in a way that is not possible in India and South Asia.

4.2 2002 Water Act

The 2002 Water Act focuses on modernising old irrigation systems and on-demand management. The law provides substantial powers to the Department for Water Administration to take responsibility for developing nationwide systems of water licensing and water charging across regions and sectors, and between rural and urban areas, to meet rapid economic growth needs.

The act promotes water conservation in all sectors of the economy. Conservation will be implemented through advanced technologies, such as GIS, extensive use of pumps, assured availability of electricity, improved canal systems which assure water supplies for farmers, investment in agricultural research and development, and the management of water-related disasters. Extreme floods and droughts regularly afflict China. The latter has occupied the authorities for at least two decades. In 2012, there was acute drought in five provincial administrative units in south-west China and extreme flooding on the Yangtze River. Severe flooding in south-west China's major rivers led to a logging ban in forested areas, which impacted the employment of about one million households. The China Council for International Cooperation on Environment and Development (CCICED) formed an international task-force to reconcile deforestation in the upper reaches of watersheds and deal with pressures of urbanisation, water requirements, environmental needs, and the protection of households whose livelihoods depend on the forests.[ii] The CCICED task-force in 2000–2001 reviewed the implementation of the logging ban policy and introduced payment for environmental services (PES) following examples from other parts of the world. The CCICED task-force strengthened China's commitment to adopt a major programme of PES with a landscape approach. The impact of this policy, particularly on watershed protection, is strongly debated by experts (Lele et al., in print), but Gyani Zhao, President of International Commission on Irrigation and Drainage, stresses that it has stabilised water flows in major rivers and improved water quality (personal communication, 2012).

The 2002 Water Act also emphasised the need for capacity building in soil and water conservation at all levels in the irrigation and drainage sector, and particularly in arid and semi-arid areas. The law provides compensation for those affected by construction and irrigation development. It also promotes volumetric water measurement as a basis for water charges as well as a system of progressive payments for water use in excess of quotas. The law promotes the use of water-saving technologies and measures to minimise leakages in water storage and transmission. The Water Act also gives priority to promoting agriculture in water-deficient regions. Empirical research on how this law is implemented would provide invaluable insights for others to learn from.

4.3 Irrigation's hierarchical structure

Irrigation in China has a hierarchical structure comprising irrigation districts that oversee station management, which in turn oversee canal management and farmer run WUAs. An important feature of this arrangement is that WUAs are expected to work with station management agents and be mutually supportive in developing both technical and participatory approaches to irrigation management.

The Water Department, representing the government under the oversight of the State Council, is expected to play a strong leadership role in developing national plans and regulations and modifying related regulations and policy and legal arrangements. It will also focus on capacity development and financial arrangements. Management agents are responsible for benchmarking and evaluating irrigation operations, designing and rehabilitating the main irrigation structures and canals, and implementing institutional reforms. They are the bridge between the government and the WUAs, providing technical support, testing, and introducing new technologies to support irrigation system management. The WUAs are responsible for rehabilitating farm canals, operating and maintaining canal systems, and providing irrigation services to water users while also collecting their water fees. Irrigation system management reform included establishing WUAs; developing a contract responsibility system; a rental system; and water pricing and trading system that facilitates possible water trading amongst WUAs.

China's most recent south-to-north water transfer project is one of the largest in the world. This will transfer water through a major canal system from south China, where water is abundant, to the north where water is in short supply. How it will be implemented and its likely impacts are as yet unknown.

China has invested heavily in canal lining. The medium- and long-term effects of this, particularly on groundwater recharge and biodiversity protection, remain controversial. However, it has assured water supplies to farmers relying on canal irrigation. Most observers note that China's average canal irrigation efficiency of 50+ percent[iii] is comparable to that of most other well run irrigation systems (up to 75 percent is possible in the best systems). There is extensive investment in pumped irrigation, and extensive use of farm budgets and water allocation measures. But Chinese analysts question if this allocation system is based on real farm needs. Volumetric pricing of irrigation services is the bedrock of irrigation system management. Irrigation service fees vary considerably from US$70/ha (CNY450/ha) for canal irrigation to US$450/ha (CNY3,000/ha) for pumped irrigation. The latter is used mainly for high value crops, such as vegetables and fruit. Significantly, high service fees have driven farmers to economise on water use. Several studies are under way to assess the impact of the new policies on water use and productivity. While there are still many issues to resolve, water allocation and pricing mechanisms in agriculture and the dual approach of WUAs and irrigation managers seems to be working. This strategy is also supported by the increased voice of stakeholders in the policy-making process and China has demonstrated enormous capacity to learn from its own mistakes and those of others.

4.4 Increasing water productivity

China's knowledge of its hydrological resources is superior to India's. This was further enhanced in 2012 by the first nationwide water survey to update their knowledge base on water resources, associated infrastructure, and water management (Government of China, 2012). Chellaney (2011) attributes China's well-developed hydro-power strategy to the fact that China's top leaders are from engineering backgrounds. He contrasts China's efficiency in planning and implementation to India's lower performance. The implementation experience of the World Bank's projects in China typically receive higher performance ratings than the projects of the World Bank's other large 'water' clients, including India. This confirms Chellaney's observations (Figure 7).

China's hydro-power capacity and water storage capacity (340 billion m^3) have increased substantially. And yet hydro-power is less significant in providing power than coal, on which both China (much like India) relies heavily.

4.5 Involuntary resettlement policies

The need for infrastructure development in land-short countries inevitably results in resettling people. China has far too often been constrained by the lack of a transparent and fair land acquisition and resettlement policy. Between 1950 and 2008, 70 million people were affected by resettlements in China as a result of development projects. About 26.14 million people were affected by the construction of 86,000 reservoirs), 15 million were affected by investment in transport and communication, and 40 million by urban construction and other development projects (Shi, 2011).[iv] The resettlement budget for the Three Gorges Dam was US$5.4 billion, 45 percent of the project budget. This was increased to US$12 billion in May 1993, and the final cost for implementation was US$11 billion. Final costs of the Three Gorges Dam are still being debated. According to Shi, it is not unusual for 40 percent of a hydro-power project budget to go towards resettlement. China learnt from the involuntary resettlement and rehabilitation policies and guidelines developed by the World Bank. The World Bank helped by establishing a large research and training centre at Hohai University to address resettlement risks, and to learn and convert those risk management strategies into resettlement policies, guidelines, and textbooks. Although resettlement associated with dams has always been a source of international controversy, independent evidence, including World Bank evaluations, suggest that China learnt systematically from the Bank's resettlement policies and has managed involuntary resettlement far better than other countries (Lele et al., in print). China's policy is to provide a higher standard of living to those resettled than they previously enjoyed. This does not mean that moving poor people is either desirable or easy, particularly in a democracy, but if they have to be displaced involuntarily to meet a country's infrastructure needs, they are more likely to be economically better off in China than in most countries.

4.6 Groundwater in northern China

Only 18 percent of China's irrigation comes from groundwater, mostly in northern China. About 62 percent of the 246 billion m^3 of groundwater are stored in aquifers dominated by piedmont alluvial plains (Zhang et al., 2008). Users abstract about 80 billion m^3 annually. Little research has been done on the impacts of the emergence of this groundwater economy, which is one of the most notable developments during the past 20 years (Huang et al., 2010). By 2005, there were more than 3.5 million tube wells irrigating about 15 million ha. There are few controls on abstraction, but to date this has not led to a 'tragedy of the commons'.

Two important reforms were the introduction of WUAs and contract farming, but as yet their impacts are not clearly known. Some argue that it is not so much the reforms that matter, rather it is the creation of new management institutions and monetary incentives for managers that has led to water savings (Wang et al., 2006). Increasing groundwater scarcity and policy interventions have led to shifts in tube well ownership patterns. Fiscal subsidy programmes directly extended funding to single farmers for tube well investment and this promoted the emergence of private tube wells. Over the last 15–20 years collectively owned tube wells have been gradually privatised. This has led farmers to move into more water-sensitive and high-valued crops with a consequent positive impact on incomes, poverty, and income distribution. In Hebei and Henan provinces, poverty fell from 30 percent in 1985 to less than 9 percent in 2001 (Wang et al., 2007). But increasing privatisation has also been associated with falling water tables.

5 Selected experiences from other countries

5.1 In Pakistan

The most dire threat to the country is the increasing intensity of flood events, which cause about US$6 billion of damage annually – four times greater than a century ago. Gillani (2011) stresses the need to increase investments in dams and canal lining as the response to climate change. Dams became intensely controversial issues in the 1980s, in part because of the Narmada Dam (which led to the establishment of the inspection panel in the World Bank). Questions were also raised about the benefits of lined canals on the grounds of effectiveness and environmental costs – loss of biodiversity, impact on watershed recharge, and impacts on equity. Proponents of lined canals argue that the high water losses from seepage in lined canals in India (only 35 percent of the water reaches farmers' fields compared to 50 percent in China and a world average of 50 percent) are a result of the poorly designed and implemented, labour-intensive construction of earth canals, which slow implementation and increase the management costs of supervising labour. Whether true or not, these issues need empirically grounded studies.

Like India, Pakistan faces multiple challenges. Groundwater has increased cropping intensity, but also has led to falling water tables. In the Indus basin, water tables are falling at a rate of 1.5 m per year. In Baluchistan the pace of decline is even faster. Pakistan's biggest opportunity lies in improving surface water management. Policy-makers stress that Pakistan needs to build more surface storage. Current storage capacity is only 15 percent of average river flows. About 30 percent of this storage is expected to be lost to siltation by 2025. As snowmelt becomes less reliable, Pakistan will become increasingly dependent on rainfall at higher altitudes. Rainfall provides 59 percent of the Indus flows – and 85 percent of this falls during the monsoon, making storage a critical priority.

Similar to the coastal areas of India, Pakistan's coasts are also threatened by salinity. Irrigation, according to Gillani, adds one tonne of salt per hectare every year. As a result 22 percent of Punjab and 78 percent of Sindh have highly saline groundwater. In all likelihood, climate change will worsen the situation for Pakistan as surface water flows decline and groundwater dependence increases.

Managing system losses is also a critical part of improved surface water management. Minimising evaporation losses and spreading seepage losses evenly over the canal command should improve conjunctive management and alleviate many of its groundwater-related problems. Today, farmers in the head-reach of the Ibis receive the bulk of the surface water supplies; mid-reach farmers receive some 20 percent less than the head-reach farmers, and tail-end farmers get 20 percent less than the mid-reach farmers. If evened out, this spatial bias in canal water delivery would maximise the benefits of the conjunctive use of surface and groundwater.

Cooperation between India and Pakistan would also help to deal with many of the issues common to both countries. Building trust between them would be critical to increasing cooperation which, in turn, may improve the way in which they both address their more thorny issues. The availability of reliable hydrological data is critical for establishing trust within India and across neighbouring countries. Collecting reliable hydrological data is costly, but overdue, in the context of likely changing hydrological cycles.

5.2 In South Africa

South Africa is ranked 29th (out of 193) in terms of available water resources per capita. Water management is explicitly addressed in South Africa's constitution in a number of different contexts. First it is viewed as an 'indivisible national asset'. Unlike India, the National Water Policy (1997) declared that the national government is the primary custodian of South Africa's water resource, with sole responsibility for its management. Provinces also have responsibility for certain water-use sectors, such as agricultural and municipal use, and certain conservation and pollution control functions. The policy's inclusion of a 'right to water' placed a duty on the national government to take the necessary legislative and other measures to achieve this. The constitution provides for centralising water management and insulating it from 'political federalism' while maintaining the division of powers and functions between different levels in a federal system. Muller (personal communication, 2012) argues that by allocating water resource management functions down to the sub-regional level, such as in Australia, western USA, and India, political federalism can pose serious challenges to effective water management. Also basin federalism can create difficulties, specifically conflicts between legitimate political institutions of general governance and the more specialised agencies of basin management.

South Africa has avoided the unnecessary challenges that federalism can bring based on learning from the experience of other countries. Responsibility for water and sanitation services rests with local governments, while the national and provincial governments have concurrent legislative responsibility for their performance, regulation, and intervention. The allocation of powers is based on the level at which decisions are most effective and at which accountability can be best enforced to ensure the quality of service provision. The national government is empowered to intervene through legislation or such other steps as may be defined in the constitution, while maintaining national responsibilities, such as the operation of multi-regional and international water schemes; international water relations; and inter-regional water resource planning and development; conflict mediation; and long-term national water resource planning. The sub-regional level agencies also have a key role to play in the overall management of the water resources within their given region. These functions include the management of water resource systems to assure bulk water supplies within a region; abstraction, treatment, and bulk water distribution; identification and control of waste-water discharges into river systems; and the management of water quality.

While the constitution dictates that some resource management functions be undertaken on a catchment basis, generic water management areas rather than river basins themselves are the primary unit of management in South Africa. The national water authority retains overall responsibility for planning, allocation (including inter-basin transfers), and transboundary management issues, It also retains oversight powers over water administration within basins (Muller, undated). Muller also notes that South Africa's water management areas (WMAs) – which do not follow either political or river basin boundaries – are assigned specific functions. Major rivers are divided among a number of different WMAs (bringing together stakeholders served by common systems or in reasonable proximity to each other and with common interests), while smaller rivers were clustered into single WMAs (to avoid a proliferation of agencies).

South Africa still faces a variety of water management challenges, ranging from long delays in issuing water-use licences, incoherent licence conditions, uncontrolled illegal water use, and widespread pollution of rivers (Muller, 2012). The catchment management agencies that undertake many water resource management functions have taken time to establish.

Reconciling the interests of many stakeholders remains a challenge, but the lack of trust and consensus among stakeholders has led them to agree on one thing – the government must take the lead in these management issues to help all parties fill the 'trust deficit' (Muller, 2012). Other problems include competition for water between industry and agriculture, and rural communities having insufficient access to water resources.

5.3 In sub-Saharan Africa

Sub-Saharan Africa faces far less pressure on water resources from population growth than Asia. However, its overwhelming reliance on rainfall and concerns about climate change mean that Africa shares many of the same challenges as rainfed agriculture in Asia. Africa's abundant water resources are unevenly spread relative to the population making it difficult to make economic use of water for hydro-power or irrigation. The Asian experience has some potentially important lessons for the region where food and water security are increasingly viewed as being interconnected with the growth of irrigation.

Following the GWP workshop in South Asia, the Development Bank of Southern Africa, in partnership with GWP, IWMI and South Africa's National Planning Commission, organised a workshop in Midrand, South Africa, with the support of South African Development Community, the East African Community, and the African Development Bank (GWP and Development Bank of South Africa Ltd., 2012).

Many of the conclusions that emerged from the workshop noted that, in Africa, the achievement of food security means both creating employment and livelihoods in the agricultural sector, and also increasing overall broad-based growth. Given the small size of the markets for food and water, regional cooperation in energy, transport, trade, manufacturing, and climate change is important. However, cooperation is constrained by insufficient links between policy and project development, lack of finance, and a lack of cooperation among countries that would promote regional integration.

6 Lessons from India, China, and others

The evidence from China and India, and selectively from other countries, suggests that besides being one of the most complex sectors, water management is a more complex challenge in democratic and decentralised countries, such as India. There are more competing interests at each political, administrative, and basin level, than in unitary centrist states, such as China. The challenge starts with their constitutions, which define property rights to land, water, and forests.

In the Chinese constitution, ownership of land, waters, forests, mountains, grasslands, and other natural resources by the state means 'by the whole people'. This provides the state with considerable autonomy and flexibility in using and developing those resources. In the case of South Asia, Hirashima (personal communication, 2012) contends that water needs to be declared a national resource. Yet China has also seen dramatic shifts in land and water management with an increasing shift to private management and ownership and use of market incentives, albeit in a situation of greater overall state control. Economic growth and urbanisation have both necessitated and led to growing water and energy demands. These, in turn, lead to increased awareness of the environmental challenges posed by growth. China's policies and priorities place inter-sector and inter-regional considerations centre stage to assure continued economic growth and higher living standards. A number of demonstrable outcomes come from these policies, and the investment and institutional choices they have prompted. Yet China's approach is by no means without controversy on such issues as dams, canal lining, population resettlement, and watershed management. Although China is allowing greater dissent and incorporating local concerns into its investment decisions, its policy-making processes still remain enigmatic. Yet the outcomes are evident. A centrist state is able to make and implement decisions more rapidly at multiple levels than is typical in democracies.

In democratic and increasingly decentralised India, constitutionally land and water are state subjects with the role of the central government confined to intra-national, inter-state, and trans-national boundary water issues. With rapid economic growth and higher rates of population growth on smaller land areas, India too has encountered controversies in many of the same areas as China. But with the greater powers of the Indian states and local governments, increasing political influence, weak institutional capacity, and weakening central authority and leadership, India's decision-making processes are slow, and ambiguous in responsibility and accountability, implementation, and outcomes. Evidence suggests that India's outcomes in sustainable agricultural water management are lacklustre. Facing immense competition for water, and drawing on the collective action experience of the post-independence era, India's Ministry of Water Resources announced a draft National Water Policy in June 2012 and the government announced its 12th five-year plan to redress past weaknesses. The draft water policy is contributing to an already active debate on the appropriate balance between centralised and decentralised approaches to water management and governance in India. The extent to which India will be able to provide decisive central direction, develop nested multi-level solutions, and implement them effectively, rapidly, and sustainably through democratic means, is unclear, although there are a handful of encouraging examples that are discussed in this paper.

Morocco and South Africa, both water scarce countries, have undergone major water policy and organisational reforms. In Morocco, modern, large-scale irrigation – the centrepiece of its irrigated agricultural development – rapidly built or modernised nearly 683,000 ha out of a potential of 850,000 ha (Ait-Kadi, undated). It is undergoing major reforms in pricing, cost recovery, and river basin management and yet faces substantial domestic and international policy challenges. The South African policy was to correct past inequities, centralise water management responsibility with the national government, avoid the pitfalls of political federalism, and, at the same time, put a wedge between land ownership and ownership of water resources while giving water rights to communities (something which the Indian policy is proposing). Experience during implementation suggests that the principle of community rights is broadly accepted in South Africa, but weak local institutional capacity poses a challenge for implementation. Some in India have attempted to draw lessons from South Africa's water policy, but others view community ownership of water resources with scepticism, given the growing evidence of elite capture of land and mineral resources. They in turn reflect deteriorating governance and weak accountability mechanisms.

Asymmetric information on country policies and performance poses challenges to learning strategic cross country lessons. There is a paucity of empirical evidence after nearly 20 years of global acceptance of the Dublin principles.

More is known about the policy-making processes (or their absence) and the slow pace of implementation in India than in China. This is because English is the lingua franca and there are a transparent activist media, civil society, and judiciary. Yet it is clear that large engineering projects are more likely to thrive in centrist states than in the more decentralised ones. Indeed, they seem to perform well in China. Yet, when transparent internal dialogue and processes are absent, centrist countries are also prone to make major mistakes – in some cases such decisions may prove to be disastrous. Over time and compared to other countries, China has demonstrated considerable evidence of learning-by-doing, and becoming more participatory and responsive to local concerns. Yet the future directions of China's brand of central direction and local participation remain unclear.

The Asian and African experiences offer useful insights for the analysis of policies and institutions as an input into developing agriculture and water policies in Asia and Africa. Though the solutions cannot be transferred between China and India, or between Asia and Africa. In situations of weak governance and weak community capacity, it is risky to undertake technologically demanding hardware projects. This is particularly relevant where there is increasing interest in investment in dams to achieve water, energy, and food security in light of rising food and energy prices and growing resource scarcities. Yet in the specific case of water, which knows no boundaries, effective small-scale water management solutions are necessary, but may not be sufficient, in the face of growing intra-country and inter-country transboundary competition at multiple levels, impending threats of climate change, and differential state capacities for collective action. Three areas are needing urgent attention:

- Better, more reliable and transparent information on the changing nature of hydrological, demographic, and socioeconomic pressures at all levels, and an understanding of their complex interactions;
- Empirically based, methodologically sound analyses of the realities on the ground as an essential input into developing normative policy prescriptions, including IWRM approaches;
- Awareness raising, information, and advocacy campaigns among people and decision-makers at all levels to develop consensus on the seriousness of the water challenge. This is an essential ingredient in developing effective solutions that are effectively implemented.

7 A role for IWRM

The experiences of India and China continue to demonstrate the need for an integrated approach to water management. This requires using the instruments of an enabling environment, institutions, and fiscal instruments, which together can help to improve the governance of water and food. What is clear, is that the water management challenges that India and China face today and tomorrow are very different from those in recent decades. There is a general consensus that today's water-use patterns and environmental trends, if continued, will lead to major crises in many parts of the world. To meet the acute fresh water challenges facing humankind over the coming 50 years a new approach is needed. An approach that sets agricultural water management within an integrated water management process and which integrates the productivity of agricultural water within the broader context of ecosystem sustainability is required. This approach will need a framework for integrating policies – macroeconomic policies, water management policies, agricultural policies, trade policies, rural development policies, environmental policies etc. It will also need to integrate institutional changes and investments to achieve efficient outcomes in all aspects of agricultural water management – from modernisation of large-scale irrigation systems to enhancing water management in rainfed agriculture, and better linking livestock and fishery practices to water management. Fragmented approaches are no longer an option. Progress may be slow and the questions complex, but there is no real alternative to integration.

References

Ait-Kadi, M. (Undated) Irrigation water pricing policy in Morocco's large scale irrigation projects. *Options Mediterraneennes* A(49): 52–71.

ANAI, Ecoagriculture Partners, Bioversity International, World Agroforestry Centre, IUCN (2008) *Applying the ecosystem approach to biodiversity conservation in agricultural landscapes.* Ecoagriculture Policy Focus 1(1). Ecoagriculture Partners, Washington, DC.

Aquastat–FAO (2012a) Total water withdrawal by sector. http://www.fao.org/nr/water/aquastat/dbase/AquastatWorldDataEng_20101129.pdf

Aquastat–FAO (2012b) Information system on water and agriculture. http://www.fao.org/nr/water/aquastat/main/index.stm

Arezki, R. and M. Brückner. (2011). *Food prices and political instability.* IMF working paper WP/11/62. International Monetary Fund, Washington, DC.

Bigas, H. (Ed.) (2012) The global water crisis: addressing an urgent security issue. Papers for the InterAction Council, 2011–2012. United Nations University, Institute for Water, Environment and Health, Hamilton, Canada.

Binswanger, H.P., Khandker, S.R. and Rosenzweig, M.R. (1993) How infrastructure and financial institutions affect agricultural output and investment in India. *Journal of Development Economics* 41(2): 337–366.

Bobenrieth, E., Wright, B. and Zeng, D. (2012) Stocks-to-use ratios as indicators of vulnerability to spikes in global cereal markets. Paper presented at the 2nd Session of the AMIS Global Food Market Information Group. FAO, Rome, 3 October 2012.

Bourgeois, R. (2012) *The State of Foresight in Food and Agriculture and the Roads Toward Improvement. Part 1: Foresight Report to the Global Conference on Agricultural Research for Development II – September, 2012.* EGFAR–FAO, Rome.

Chellaney, B. (2011) *Water: Asia's New Battleground.* Washington, D.C.: Georgetown University Press.

Comprehensive Assessment of Water Management in Agriculture (2007) *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture.* Earthscan, London: and IWMI, Colombo.

Dar, W. (2011) *Agriculture Year Book 2011: Revitalizing Rainfed Agriculture for India's Second Green Revolution.* International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh.

Economic & Political Weekly (2012) Editorial: When the water runs out. XLVII (22) 2 June [Mumbai, India]

Facon, T. and Mukherji, A. (2011) Improving the performance of public irrigation in South Asia. Paper presented at the GWP/IWMI Workshop on Climate Change, Food and Water Security in South Asia, Colombo 23–25 February 2011.

Faures, J-M. and Mukherji, A. (2011) *Trends and Drivers of Asia Irrigation*. FAO, Rome: and IWMI Colombo. Also available at http://waterknowledgehub.iwmi.org/PDF/Trends_and_Drivers_of_Asian_Irrigation.pdf

Food and Agriculture Organization of the United Nations (FAO) (2011) *The State of Food and Agriculture 2010–2011. Women in Agriculture: Closing the Gender Gap for Development*. FAO, Rome.

Food and Agriculture Organization of the United Nations (FAO) (2012) *FAO Statistical Yearbook 2012 World Food and Agriculture Part 4: Sustainability Dimensions*. FAO, Rome.

Food and Agriculture Organization of the United Nations, World Food Programme and International Fund for Agricultural Development (FAO, WFP and IFAD) (2012) *The State of Food Insecurity in the World 2012: Economic Growth is Necessary but Not Sufficient to Accelerate Reduction of Hunger and Malnutrition*. FAO, Rome.

Foster, S. (2011) Sustainable groundwater irrigation, the GW.MATE vision on resource use and management approaches. Paper presented at the GWP/IWMI Workshop on Climate Change, Food and Water Security in South Asia, Colombo 23–25 February 2011.

Fuglie, K. (2012) Productivity growth and technology capital in the global agricultural economy. pp. 335–368. In *Productivity Growth in Agriculture: An International Perspective* (Fuglie, K., Wang, S.L. and Ball, V.E., Eds.). CAB International, Oxfordshire, UK. ISBN 9781845939212

Gilbert, N. (2012) Water under pressure: a UN analysis sets out global water management concerns ahead of Earth Summit. *Nature* 483: 256–257.

Gillani, N. (2011) Institutional mechanism for managing hydrological extremes. Paper presented at the GWP/IWMI Workshop on Climate Change, Food and Water Security in South Asia, Colombo 23–25 February 2011.

Global Water Partnership (GWP) (2012a) *Groundwater resources and irrigated agriculture – making a beneficial relation more sustainable*. A GWP Technical Committee Perspectives Paper. GWP, Stockholm.

Global Water Partnership (GWP) (2012b) *Increasing Water Security – A Development Imperative*. A GWP Technical Committee Perspectives Paper. GWP, Stockholm.

Global Water Partnership (GWP) (2000) *Integrated water resources management*. TEC Background Paper No 4. Global Water Partnership, Stockholm. www.gwp.org

Global Water Partnership (GWP) and Development Bank of Southern Africa Ltd. (2012) *Proceedings of the Workshop Regional Approaches to Food and Water Security in the Face of Climate Challenges*. Midrand, South Africa. 23–24 May 2011. GWP, Stockholm, Sweden and Development Bank of Southern Africa.

Godbole, M. (2009) *The Judiciary and Governance in India*. Rupa and Company, New Delhi.

Government of China Ministry for Water Resources (2012) The Ministry of Water Resources is the Chinese Government department responsible for water administration. www.mwr.gov.cn/english/.

Government of India, Ministry of Water Resources (2011) Report of the Working Group on Major and Medium Irrigation and Command Area Development for the XII Five-year Plan, 2012–2017: DRAFT. Government of India, New Delhi.

Gyawali, D. (2011) *Climate Change and the Himalayan Highlanders: A Toad's Eye View of the Problem and Responses*. Water Conservation Foundation, Kathmandu, Nepal.

Hertel, T. (2010) The global supply and demand for agricultural land in 2050: a perfect storm in the making? Presidential Address presented at the Annual Meeting of the Agricultural and Applied Economics Association. Denver, 25–27 July 2010.

Hirashima, S. (2008). The land market in development: a case study of Punjab in Pakistan and India. *Economic & Political Weekly*, 18 October pp. 41–47.

Huang, Q., Rozelle, S., Howitt, R., Wang, J. and Huang, J. (2010) Irrigation water demand and implications for water pricing policy in rural China. *Environment and Development Economics*, 15(3): 293–319.

Humber, Y., Kuwako, K. and Inajima, T. (2012) China buys Japan water rights on two-decade land price slump. The Washington Post, 6 November. http://washpost.bloomberg.com/Story?docId=1376-MC14UW6JTSF901-28QRC1KGFRPVDP8ATLO123P3OJ

Indian Council of Agricultural Research (ICAR) and Asia-Pacific Association of Agricultural Research Institutions (APAARI) (2012) *Global Conference on Women in Agriculture: Synthesis Report*. ICAR, New Delhi and APAARI, Bangkok.

International Conference on Water and the Environment (ICWE) (1992) The Dublin Statement and Report of the Conference. 26–31 January. ICWE, Dublin.

International Water Management Institute (IWMI) (2009) Strategic analyses of the national river linking project (NRLP) of India Series 5. *Proceedings of the Second National Workshop on Strategic Issues in Indian Irrigation*. IWMI, New Delhi.

Iyer, R. (2011) Briscoe on the Indus Treaty: a response. *Economic & Political Weekly* XLVI(3) 15 January. [Mumbai]

Kerr, J.M. (1996) *Sustainable Development of Rainfed Agriculture in India*. Discussion Paper No. 20. International Food Policy Research Institute, Environment and Production Technology Division. Washington, DC.

Khalequzzaman, M. (1993) *Farakka Barrage: History, Impact and Solution*. University of Delaware, Newark, DE.

Lele, U., Agarwal, M., Timmer, P. and Goswami, S. (2011) Patterns of structural transformation and agricultural productivity growth, with a special focus on Brazil, China, Indonesia and India: DRAFT. Paper prepared for Policy Options and Investment Priorities for Accelerating Agricultural Productivity Growth, 9–11 November 2011. Indira Gandhi Institute of Development Research (IGIDR) and Institute for Human Development (IHD), New Delhi. Forthcoming as World Bank Working Paper.

Lele, U., Karsenty, A., Benson, C., Féstiveau, J., Agarwal, J. and Goswami, S. (in print) *Changing Roles of Forests and their Cross-Sectorial Linkages in the Course of Economic Development*. Background Paper 2. United Nations Forum on Forests (UNFF), Istanbul. http://www.un.org/esa/forests/

Mahajan, V. and Navin, T. (2012) *Microfinance in India: Growth, Crisis and the Future*. BASIX, Hyderabad.

Mansuri, G. and Rao, V. (2012) *Can Participation Be Induced? Some Evidence from Developing Countries*. Policy Research Working Paper No. 6139. The World Bank, Washington, DC.

Mohtadullah, K., Shah, T. and Qureshi, A. (Undated) China's U.S. $ 600 billion, 10 year irrigation modernization program. Report on a field visit to the National Centre for Efficient Irrigation, Beijing.

Mukherji, A. (2011) Paradox of poverty amid plenty of groundwater. Paper prepared for the GWP/IWMI Workshop on Climate Change, Food and Water Security in South Asia, Colombo 23–25 February 2011.

Mukherji, A., Shah, T. and Banerjee, P.S. (2012) Commentary: Kick-starting a second green revolution in Bengal. *Economic & Political Weekly* XLVII(18), 5 May pp. 27–30. [Mumbai]

Mukherji, A., Sarkar, A., Das, A., Chanana, N., Shah, T. and Malik R.P.S. (2011) *Energy, Agriculture and Groundwater Nexus in Punjab*. International Water Management Institute, New Delhi.

Muller, M. (Undated) Allocating power and functions in federal design: the experience of South Africa. Draft book chapter.

Muller, M. (2012) Working together to manage SA's water better. *Business Day*. 19 January 2012. [South Africa]

Narain, S. (2012) Excreta matters: citizens' report on the state of India's environment. An agenda for water-prudent and waste-wise India. http://www.cseindia.org/content/excreta-matters-0.

Organisation for Economic Co-operation and Development/Food and Agriculture Organization of the United Nations (OECD/FAO) (2012), *OECD–FAO Agricultural Outlook 2012–2021*, OECD Publishing, Paris: and FAO, Rome.

Ostrom, E. (2009) *A Polycentric Approach for Coping with Climate Change*. Policy Research Working Paper 5095, Background Paper to the 2012 World Development Report. The World Bank. Washington, DC.

Paranjape, S., Joy, K.J. and Gujja, B. (2010) Babhli water conflict: less water, more politics. *Economic & Political Weekly* XLV(31) 31 July. [Mumbai]

Poteete, A., Janssen, M. and Ostrom, E. (2010) *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton University Press, Princeton, NJ.

Sadoff, C. and Muller, M. (2009) *Water Management, Water Security and Climate Change Adaptation: Early Impacts and Essential Responses*. Background Paper No 14. Global Water Partnership, Stockholm.

Sadoff, C. and Rao, H. (2011) The Ganges strategic basin assessment. Paper presented at World Water Week. Stockholm. 21 August 2011.

Samad, M. (2011) Irrigation management reforms: the Asian experience. Paper presented at the GWP/IWMI Workshop on Climate Change, Food and Water Security in South Asia, Colombo 23–25 February 2011.

Schmidhuber, J. (2012) The Agricultural Market Information System AMIS: what it is, where its focus lies and why. Paper presented at the American Academy of Arts and Sciences Conference, Vancouver. 15–21 February 2012.

Shah, T. (Undated) *Issues in the Governance of Agricultural Water Use in South Asia*. International Water Management Institute, Gujarat.

Shah, T. (2009) Climate change and groundwater: India's opportunities for mitigation and adaptation. *Environmental Research Letters* 4: 1–13.

Shah, T. and Lele, U. (Eds.) (2011) *Synthesis of Workshop Discussions. Climate Change, Food and Water Security in South Asia: Critical Issues and Cooperative Strategies in an Age of Increased Risk and Uncertainty*. GWP, Stockholm and IWMI, Colombo.

Shi, G. (2011) Changes and achievement in the policies and practices in involuntary resettlement and social assessment in China from 1980s to 2010s. Paper presented at the National Research Center for Resettlement, Hohai University, China.

United Nations, Educational, Scientific and Cultural Organization (UNESCO) (2008) Irrigated land as percentage of cultivated land.
http://www.unesco.org/pv_obj_cache/pv_obj_id_2A87741EBB3F4AA86F0441F714E36393668B0200/filename/Irrigated_land_as_a_percentage_of_cultivated_land.pdf

Venot, J-P. (2008) Why and where are the Krishna waters disappearing? *Economic & Political Weekly* XLIII(6) 9 February 2008. [Mumbai]

Wang, J., Huang, H., Rozelle, S., Huang, Q. and Blanke, A. (2007) Agriculture and groundwater development in northern China: trends, institutional responded, and policy options. *Water Policy* 9 (Supplement 1): 61–74.

Wang, J., Xu, Z., Huang, J. and Rozelle, S. (2006) Incentives to managers or participation of farmers in China's irrigation systems: which matters most for water savings, farmer income, and poverty?, *Agricultural Economics* 34: 315–330.

World Bank (Undated) *World Development Indicators, World Data Bank*. World Bank. Washington, DC.
http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators

World Bank (2012) *2012 World Development Report: Gender Equity and Development*. The World Bank, Washington, DC.

World Water Assessment Programme (WWAP) (2012) *The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk*. United Nations, Educational, Scientific and Cultural Organization, Paris.

Wouters, P. (2012) *Facilitating transboundary water cooperation – the contribution of international law, with a focus on the global water partnership experience.* Working Draft.

Wright, B. D. (2011) The economics of grain price volatility. *Applied Economic Perspectives and Policy*, 33(1): 32–58.

Zhang, L., Wang, J., Huang, J, Rozelle, S. and Farnsworth, H. (2008) Development of groundwater markets in China: a glimpse into progress to date. *World Development* 36(4): 706–726.

[i] Individual World Bank funded projects suggest a similar record. For example, in 1997 the Bank supported water management in Uttar Pradesh and announced a paradigm shift to a river basin approach with a long-term – 15–20 year – programme of support to achieve 'fundamental reforms'. The emphasis was on tariffs; IWRM; creating new agencies to expedite institutional policy and fiscal reforms; 'right sizing' the irrigation department; modernising management, information systems, staff skills, and a long-term legal framework. The Bank identified lack of coordination among departments, lack of information for planning, lack of participation of user groups – with all the money going into establishment and little funds left for operation and maintenance – poor information systems for planning, lack of a role for the private sector, and low water productivity because of an unreliable supply.

[ii] This task-force was chaired by the author.

[iii] This is the ratio of the amount of water needed by a crop to the amount turned into a canal at the head works. This value does not account for any possible reuse of seepage water by others downstream.

[iv] This includes 1.3 million affected persons (1993–2009) from Three Gorges Dam: 80,000 affected persons (WB, 1987–1996) from Shuikou Dam: 200,000 affected persons (WB, 1994–2004) from Xiaolongdi Dam, 25,000 affected persons (ADB funded) from Shanxi Water Supply: 39,292 affected persons (ADB funded) from Mianhuatan Dam: 305,600 affected persons (Domestic in 1958–1962) from Xin'anjiang Dam: 382,000 affected persons (in 1958–1962) from Danjiangkou Dam: and 345,000 (new expansion) affected persons (2009–2012) (Shi, 2011).

Global Water Partnership (GWP) Secretariat
Drottninggatan 33
SE-111 51 Stockholm, Sweden
Email: gwp@gwp.org
Websites: www.gwp.org, www.gwptoolbox.org