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Review

Policy dimensions of development and financing of water infrastructure: The cases of China and India

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ABSTRACT

The past decades have seen planning and implementation of built infrastructure in all over the developed and developing world growing in large scales. This has been influenced by economic and population growths, urbanization and industrialization, which in turn have put increasing stress in provision of services. The paper reviews the policy dimensions of water infrastructure development and financing in the two largest economies at present, China and India, including planning, implementation and decision-making processes. Findings indicate that main challenges for infrastructure development have been limited sources of financing, but also policies and their implementation. The high levels of investment in water infrastructure in the two countries have been impressive, mainly in China. However, they still have not necessarily addressed efficiency over the long term, supported more inclusive and higher economic growth or improve social and environmental conditions in all cases.

1. Introduction

Infrastructural development plays a key role in economic growth and poverty reduction all over the world. Properly planned and implemented, it has the potential to contribute to national and regional economic growth, respond to urbanization challenges, contribute to improvements in environmental conditions and encourage and foster social and economic inclusion (ADB, 2013a; Estache, 2008).

In the developed world, infrastructure is mostly in need of rehabilitation and modernization. In the developing world, in addition, substantial new and upgraded infrastructure is needed because the countries need to respond to increasing economic and population growths, urbanization, and changing aspirations of the population for better standards of living.

Investments in numerous construction and modernization projects have been the results of increasing water, energy, and food-related needs as well as climate-related security (Tortajada, 2014; Kenny, 2015). Water infrastructure for domestic, agricultural, energy and environment-related uses (pipes, treatment plants, groundwater recharge and storage, rainwater harvesting, small, medium and large dams, etc.) are essential for developing countries located in the tropical and subtropical regions compared to countries in temperate zones. This is the case in India and China, where high rainfall inter- and intra-annual fluctuations result in more erratic rainfall patterns making reservoirs essential to store water whenever this is available to use it during the rest of the year (Biswas, 2012). Given that reservoirs are some of the most important buffers against droughts and that one of their most important roles is flood protection, the question arises as to whether construction of new reservoirs should be encouraged or whether small projects should be developed instead. Since new construction may not always be possible for economic, social, environmental or dogmatic reasons, a feasible alternative to new reservoirs is to look into their re-operation that can be more effective under the present, and perhaps also future, conditions. A limitation could be, however, that re-operation of reservoirs requires comprehensive policy, management, governance (formal and informal institutions and decision making processes) and financial considerations that are very complex to realize (Tortajada, 2016).

Globally, the total scale of incremental global investment requirements in infrastructure is in the trillions of dollars. In the case of the developing countries, this has been estimated at approximately $1 trillion a year (Bhattacharya et al., 2012). This amount includes universal coverage of adequate housing, water, and sanitation, in addition to modern energy and communications technology.

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Traditional overseas development assistance is not expected to be a major new source of financing for infrastructure for developing economies, as they represent around half of global GDP, adjusted for purchasing power, or one-third of GDP at market exchange rates. Therefore, even if all rich countries reached a 0.7% aid target in the foreseeable future, which is highly unlikely, this would represent only 1% of developing countries' GDP. Overseas development assistance can be more valuable in the poorest countries if it can finance public infrastructure (either directly or through guarantees or blended finance, reducing the cost of finance for infrastructure), but not for growing economies (Kenny, 2015).

Infrastructure spending has been the highest in emerging and developing economies, especially in the ones with the highest growth, China and India in particular. These two countries, together with Brazil and Russia, make up the so-called BRICs, which in 2012 produced one-quarter of global GDP. China and India, considered the global rising powers, could become much larger forces in the global economy, mainly if they are able to develop and maintain policies, institutions, and infrastructure that are supportive of growth (Wilson and Purushothaman, 2013).

In both the countries, continued population growth and urbanization have placed increasing stress on built infrastructure and provision of services in all sectors, including water supply, sanitation, electricity, irrigation, railways, roads, and ports. Capital to provide and maintain the infrastructure necessary to provide adequate services and facilities is, and will continue to be, seriously constrained. Development of infrastructure to the level of the G6 nations will represent an enormous challenge in investments needs, and, most important, in policies, laws, regulations, and institutions (UN, 2014).

The present paper discusses infrastructure development and financing in Asia in general, and in China and India in particular, with a focus on the water sector. The paper does not attempt to compare the two countries, as they are not directly comparable. They are at different stages of development, and their policies, decision-making, and political processes, as well as institutional and legal and regulatory frameworks, are dissimilar. Climate, public expectations and culture are also different. The paper explores the status of infrastructure development in both countries, covering planning, implementation, decision-making processes, and investments, as well as challenges that will have to be addressed for the countries to grow sustainably. It argues that policies, management, governance (formal and informal institutions and decision making processes) are essential elements for development of infrastructure, and allocation and reallocation of water resources, as any change will affect the several uses and users.

This paper takes a rather different view from the school that argues that built infrastructure such as large-scale pipelines, treatment plants, and drainage networks exacerbates impacts and erodes the resilience of cities (Ferguson et al., 2013). This paper argues that built infrastructure is needed at present and in the future in order to make countries more resilient if built within an overall framework of development (Muller et al., 2015). In fact, built infrastructure, green and more flexible infrastructure (as harnessing nature to provide critical services for communities such as flood protection, excessive heat, helping to improve air and water quality, etc.), and soft infrastructure (human capital and institutions) play very important roles in building more resilient human and natural environments in the long term (Palmer et al., 2015).

The following analyses are based on assessment of available literature as well as on discussions with scholars and policy makers in both China and India.

2. Infrastructure developments and investments in Asia, with focus on China and India

Asia, home to 4.3 billion people, hosts four of the largest economies of the world: China, Japan, India, and Republic of Korea. Together, they account for nearly 30% of the global GDP. Ten out of 12 economies globally with GDP growth rates of 7% or more over the past 25 years are also in Asia (Bhattacharyay, 2010). Development of infrastructure has facilitated economic growth in all of them, even though there are serious gaps between urban and rural areas in all these countries, with the rural poorest having the lowest access to all services (Straub and Terada-Hagiwara, 2011).

Asia has become the largest producer of energy in the world, with a share of 30% (4,039 million tonnes of oil equivalent) in 2013. In the region, total electricity generation increased 24% from 337.2 TWh in 1973 to 3,400 TWh in 2013. Hydro-production, driven by China, represented 7.2% (93.3 TWh) of the global production in 1973, increasing to 32.3% (1,251 TWh) in 2013 (OECD/IEA, 2015). In the water sector, even though approximately 75% of the population has access to improved sources of water (WHO and UNICEF, 2014), this does not mean that water is safe for drinking. Performance for sanitation is much lower: less than half of the population has improved sanitation as measured by the United Nations (Kuroda et al., 2008).[1]

The Asian Development Bank (ADB/ADBI, 2009) estimates that some $8 trillion in overall national infrastructure, in addition to approximately $290 billion (in 2008 dollars) in specific regional projects, will be needed in Asia from 2010 to 2020. This is an average overall investment of $750 billion per annum, with approximately 68% going to new capacity investments and 32% to maintain and replace existing infrastructure. Annual investment needs in transport, electricity, information and communications technology and water are expected to be greater than 6.5% of Asia's estimated GDP for 2010–2020. In the case of China and India, the necessary investments during this period are likely to represent some 53% and 26%, respectively, of the total investment needs in Asia, and 5.39% and 11.12%, respectively, of estimated GDP between 2010 and 2020 (Bhattacharyay, 2010).

Investments for infrastructure projects (both new and upgrades) in Asia are expected to come from domestic savings, the public sector, official development assistance, and/or loans from multilateral development banks. Mobilization of public funds and private investments and development of policy alternatives attractive for investment purposes and revenue generation to cover investment flows represent serious challenges (Jones, 2006). Private-sector contributions are still not significant in the region because of poor policies, absence of reliable legal safeguards, and changing investment conditions, often without consultation with the private-sector groups. With a proper and fair investment regime, and independent and transparent legal processes, investments from the private sector could be realized.

Relative infrastructure quality in the countries in the region is difficult to estimate. However, it is considered to be below world average and to be correlated with the competitiveness of the specific countries (ADB/ADBI, 2009). In 2003, the cost of the necessary infrastructure improvements in China was estimated to be more than $75 billion per year until 2013, 90% of it from the public sector (Bellier and Zhou, 2003). In India, according to

[1] In Millennium Development Goals monitoring, an improved sanitation facility is defined as one that hygienically separates human excreta from human contact. An improved drinking-water source is defined as one that, by nature of its construction or through active intervention, is protected from outside contamination, in particular from contamination by fecal matter.

Goldman Sachs, infrastructure development would require investments of $1.7 trillion between 2009 and 2019 (Poddar, 2009). In the least developed regions in both the countries, investments are likely to be higher as inadequate infrastructure constrains improved economic activities and affects quality of life of millions of people.

According to the 2014–2015 Global Competitiveness Report (Schwab, 2014), China's infrastructure is above the level of emerging and developing Asia's, while India is at the same level (see Figs. 1 and 2). In both cases, infrastructure development is below the global mean as it is the general situation in Asia.

Infrastructure deficit has become one of the most pressing financial, managerial, administrative, policy, and capacity challenges most governments are facing all over the world. The gap between infrastructure needs and the financial resources available for their construction and proper operation and maintenance is growing steadily. It also continues to constrain efforts to advance economic growth rates and improve quality of life. A few Asian countries have seen high levels of growth and investment on infrastructure and improved infrastructure performance outcomes, especially China. Nevertheless, high levels of investment have not necessarily meant efficient investment allocations in all cases and both the countries in general still face the challenge of addressing efficiency over the long term.

According to the WHO/UNICEF Joint Monitoring Programme (JPM) for Water Supply and Sanitation (2015), the coverage of piped water (not necessarily drinking water quality) in China is higher than in India: 73% in the first case and 28% in the second case. In urban areas, some 87% of people in China receive water in their premises compared to 54% in India. In rural areas, coverage is lower in both countries but higher in China than India: 55% compared to 16% (Tables 1 and 2).

Given that access to improved sources of water has no relation to water quality, figures in Tables 1 and 2 could be somewhat misleading as they do not represent drinking water coverage estimates.

Percentage of total population with access to sanitation services is low in both countries but higher in China with 76%, compared to India with 40%. In China, 87% of population in urban areas and 64% of population in rural areas have access to sanitation. In India, these percentages are lower: 63% in urban areas and 28% in rural areas (Tables 3 and 4).

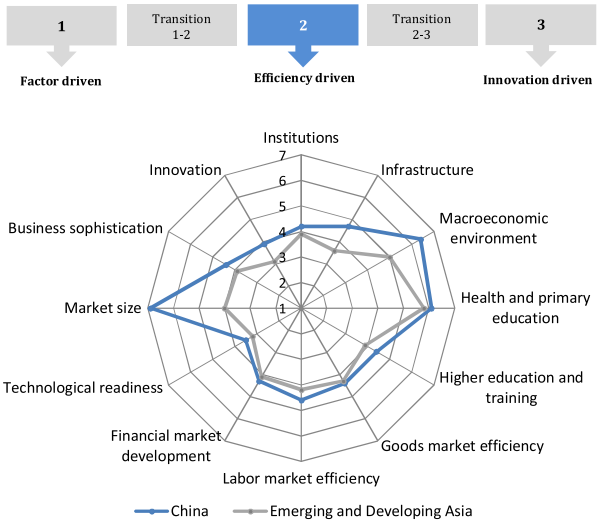

Fig. 1. Stage of development, China (from Schwab, 2014).
Source: Klaus Schwab (Ed.), The Global Competitiveness Report 2014–2015, 2014, World Economic Forum, Geneva.

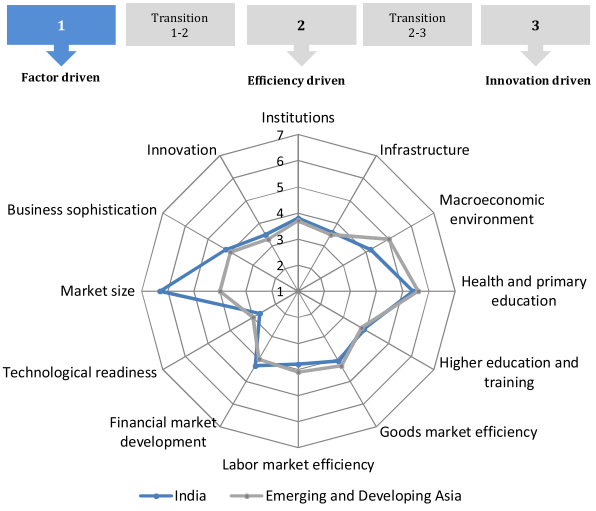

Fig. 2. Stage of development, India (from Schwab, 2014).
Source: Klaus Schwab (Ed.), The Global Competitiveness Report 2014–2015, 2014, World Economic Forum, Geneva.

Table 1
Joint Monitoring Programme estimated trends of drinking water coverage in China.

China	Drinking water coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Piped onto premises	78	87	11	55	28	73
Other improved source	19	11	45	38	39	22
Other unimproved	2	2	35	5	26	4
Surface water	1	0	9	2	7	1

Source: WHO/UNICEF JMP (2015).

Table 2
Joint Monitoring Programme estimated trends of drinking water coverage in India.

India	Drinking water coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Piped onto premises	47	54	6	16	16	28
Other improved source	42	43	58	77	55	66
Other unimproved	10	3	32	6	26	5
Surface water	1	0	4	1	3	1

Source: WHO/UNICEF JMP (2015).

A main problem in India is open defecation, mainly, but not only, in rural areas. In urban areas this is 10% but as high as 61% in rural areas.

It is important to note that sanitation is not related to wastewater treatment, which is still a problem, mainly in India.

Table 3
Joint Monitoring Programme estimated trends of sanitation coverage in China.

China	Sanitation coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Improved facilities	68	87	40	64	48	76
Shared facilities	5	6	2	3	3	5
Other unimproved	24	7	49	31	42	18
Open defecation	3	0	9	2	7	1

Source: WHO/UNICEF JMP (2015).

Table 4
Joint Monitoring Programme estimated trends of sanitation coverage in India.

India	Sanitation coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2015	1990	2015	1990	2015
Improved facilities	49	63	6	28	17	40
Shared facilities	16	21	1	5	5	10
Other unimproved	6	6	2	6	3	6
Open defecation	29	10	91	61	75	44

Source: WHO/UNICEF JMP (2015).

Regarding water pollution, the seriousness of the situation has been extensively documented (see World Bank and State Environmental Protection Administration, 2007; Shen, 2012; Maria, 2003). Pollution of rivers, lakes, groundwater, and coastal waters due to domestic, industrial, and mining discharges, agricultural runoff of pesticides and fertilizers, and lack of treatment capacity are widespread in both China and India, with very serious economic, social (including health), and environmental consequences.

Water pollution has exacerbated water scarcity and has intensified competition of water resources. The responses have been somewhat limited as they have focused mainly on increasing water supply without necessarily considering demand management (Xie et al., 2009). There are problems of inertia in environmental management that could be addressed through better management and governance, use of instruments that focus on incentives and accountability, and tariff schemes for services such as water, wastewater and sanitation, and that reflect more closely the cost for service provision. Environmental policies and regulations have been developed but incentives to implement them at the local level are still necessary to achieve their compliance (World Bank/Development Research Center of the State Council, 2014).

Water pollution has been linked to serious diseases such as liver and skin cancer, endemic fluorosis, etc., mainly in China. The government is undertaking massive construction of wastewater treatment plants across the country, whose tangible benefits will take time to be realized (Lu, 2014) but which will contribute to development if they are properly planned, constructed, operated, and maintained.

2.1. The situation in China

In China, economic growth and infrastructure development have been driven by unprecedented urbanization that has increased from 17.9% in 1978 to 53.7% in 2013, and is planned to further increase to 60% by 2020 according to the New-Type Urbanization Plan (2014–2020). Additional 128.6 million people are expected to move to cities from rural areas by 2020 and some RMB42 trillion (USD7.75 trillion) will be required to finance the New-Type Urbanization Plan over the next seven years (KPMG, 2014).

China's rapid growth has been driven by investment rather than productivity, which may make it less sustainable over the long term. Local governments are primarily responsible to fund their own urban development plans and are responsible for 80% of national spending. According to the World Bank/Development Research Center of the State Council (2014), in order to attract investments, local governments have provided subsidies in the form of inexpensive land, subsidized utilities and tax reductions. Urban development and infrastructure corporations and financing instruments have been utilized to finance infrastructure development leading to increase on local government debts to annual rates of approximately 20% in 2010–2013. It is mentioned that land has played an important role as collateral for borrowing, linking the health of local finances to land prices and real estate development. In 2013, after the National Audit Office audited local government debts, the central government decided to diversify funding sources giving the local governments more capabilities to collect revenues (e.g., commercial and residential property taxes) and expand municipal bond markets (KPMG, 2014).

With necessary reforms, the World Bank estimates that the costs of urbanization will decline as a share of GDP (Table 5). The total annual costs of all urban public services, infrastructure, and social housing, could be 6.8% in 2013–2017, 4.9% in 2018–2030 and 5.4% in 2013–2030 of GDP to due to migrant integration and

Table 5
Urbanization costs and fiscal space: Baseline and reform scenarios (%GDP).

	Baseline scenario				Reform scenario		
	2008–12	2013–17	2018–30	2013–30	2013–17	2018–30	2013–30
Urbanization costs (CAPEX and OM)	8.6	7.3	5.6	6.1	6.8	4.9	5.4
Infrastructure investment	3.5	2.7	2.5	2.5	2.1	1.7	1.8
Roads	1.9	1.4	1.2	1.3	0.9	0.7	0.7
Subways	0.5	0.6	0.6	0.6	0.6	0.6	0.6
Draining	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Sewage	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Landscaping	0.4	0.3	0.2	0.2	0.2	0.1	0.1
Garbage treatment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Water	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Heating	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Social services	5.1	4.6	3.1	3.6	4.8	3.2	3.6
Social housing	2.0	1.4	0.5	0.7	1.4	0.5	0.7
Education (includes labor costs)	3.1	3.2	2.6	2.8	3.3	2.7	2.8
Health	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Central and local governments							
Fiscal scape	33.3	31.8	30.4	30.8	29.8	29.9	29.9
Fiscal revenues	25.0	26.5	25.9	26.0	26.7	26.7	26.7
Net borrowings	8.3	5.3	4.5	4.7	3.1	3.3	3.2
Total expenditure	31.9	31.1	29.6	30.0	30.5	28.3	28.9
Recurrent primary expenditures	23.6	23.6	23.3	23.4	23.6	23.2	23.3
Capital expenditures	6.0	4.7	3.4	3.8	4.3	3.0	3.4
Interests	2.3	2.9	2.9	2.9	2.6	2.1	2.2

Note: CAPEX = capital expenditures; OM = operations and maintenance.Source: World Bank/DRC/MOF projections done for this study. World Bank/Development Research Center of the State Council (2014).

execution of the ambitious social housing programme. On the past, almost three-quarters of the cost would be paid by the governments through infrastructure development corporations and finance vehicles. This is expected to change due to the introduction of a property tax on urban residential property and appreciation of existing urban land values (For a more detailed explanation on the urbanization costs, see World Bank/Development Research Center of the State Council (2014).

During the 1992–2011 period, the country spent nearly 8.5% of its GDP on infrastructure (The World Bank mentions this percentage to be 10%). This has resulted in water production increasing by more than 50% during the past decade and power generation exceeding 330 gigawatts, making China the world's second-largest energy producer, after the United States. The country intends to add a further 200 GW of hydropower capacity during the next 10 years. This will require additional massive development of infrastructure as well as additional very large investments. In absolute terms, annual spending in infrastructure in 1992–2011 was higher than those of Japan, India, United States, the entire European Union, or Latin America (Schwab, 2013). The focus has been on water, energy, roads, rail, and ports.

Infrastructure development in China has been massive and has brought many benefits. However, it is argued that more attention needs to be paid to project selection, quality control, efficiency and equality, and long-term sustainability. Infrastructure investments still need to be higher quality, more low-carbon, and more efficient and lower pollution (KPMG, 2013).

The expected urbanization will offer numerous opportunities for economic growth but it will result in large demands of investment for infrastructure and provision of public services. It also has the risk to outpace the ability of the country to control pollution from existing and emerging sources and exacerbate already serious resource pollution and scarcity, including air, water and soil. The New-Type Urbanization Plan (2014–2020), mentions that the treatment capacity of wastewater is still insufficient, an issue that would need to be addressed in the short- and medium-terms.

There is also the concern that increasing demands for land and water may undermine the country's food security and result in high imports of key products that could in turn raise global prices (World Bank/Development Research Center of the State Council, 2014).

The largest construction project in the country, the South-to-North Water Transfer Project, is resulting in very large infrastructural development for water supply, irrigation, energy generation, and navigation (Chen et al., 2013a,b). Figures on investments needs vary according to the source. Unofficially, they are estimated at $62 billion. Officially, they are estimated at $28 billion in the case of the Eastern and Middle Route projects. No investment figures are available for the Western Route project (Office of the South-to-North Water Diversion Project, Commission of the State Council, Government of China, http://www.nsbd.gov.cn/zx/english/).

For years, China has implemented water diversion projects, mostly inter-basin, to transfer water towards the north (Liu et al., 1983). Heavily populated and polluted basins where water resources have been over-allocated, have faced serious shortages of water for domestic, agricultural and industrial uses. To overcome the shortage of water, the South-to-North water transfer was conceived in the 1950s (Ghassemi and White, 2007) to supply the arid northern regions with water sources from the Yangtze River via an eastern, central and western routes. Much has been written on this very controversial mega project (e.g. Chen et al., 2013a,b; Yan et al., 2012). Because of its magnitude, for it to result in long-term economic, social and environmental benefits, it needs to be considered within an overall framework of regional development and poverty alleviation.

2.2. The situation in India

India is less urbanized than most countries in Asia, with approximately 30% of the total population living in urban areas. According to the former Planning Commission, Government of India (2008a) now the National Institution for Transforming India (NITI Aayog from 1 January 2015, http://niti.gov.in/content/overview), the growth of rural settlements into urban areas is very slow. This includes the fact that states are normally reluctant to inform when rural settlements become towns, as central-government funds allocated to rural areas can be withdrawn.

In India, the pace of urbanization was estimated to be just over 1.15% a year between 2001 and 2011. Even then, there is continued concentration of population in large cities and agglomerations, many times in urban slums. This growth has led to increasing pressure on infrastructure (housing, water supply, sewerage and drainage, solid waste, transport, etc.) and serious problems related to inadequate service provision, pollution, poverty, and social unrest.

Strategies for development of urban infrastructure and services are mostly part of the Jawaharlal Nehru National Urban Renewal Mission. The Mission was launched as a "reforms driven, fast track, planned development of identified cities with focus on efficiency in urban infrastructure/services delivery mechanism, community participation and accountability of Urban Local Bodies (ULBs)/Parastatals towards citizens." (ADB, no date). Started in 2005 for seven years, was later extended to 2014. It considered investment of approximately $11 billion equivalent from the government of India for urban infrastructure development in 63 large cities in sectors such as water supply, wastewater, drainage, solid waste management, transport, and urban renewal (Planning Commission, Government of India, 2008b). Challenges in implementation have been many, including (among others) rigid regulations that have delayed statutory and administrative approvals and land acquisitions; lack of technically competent staff to carry out studies and operationalize decision-making; delayed disbursement of funds from the central and state governments; and increasing cost escalation.

The state of infrastructure in India has been acknowledged as an impediment to the country's economic growth. The country also has a high fiscal deficit, inflation above 8.2% annually since 2008, high public debt, steady rupee depreciation, and high public subsidies in many sectors, especially in food and energy (Planning Commission, Government of India, 2008a).

The Government of India has made very large investments in development of small, medium and large irrigation projects. The large projects have been fundamental to provide water for water supply, irrigation and hydropower. According to the OECD (2014), infrastructure investment targets have not been met in several sectors, leaving the infrastructure in poor conditions. According to the Economic Survey 2014–2015, investment on infrastructure has been much below its potential for several years. It is mentioned that the rate of growth of gross fixed capital formation dropped from 24% in the last quarter of 2009–2010, to "around zero" in the third quarter of 2014–2015 (NITI AYYOG, no date: page 2). The main reason for the slowdown in investment has been an increasing number of projects that are delayed. This has severely affected the balance sheets of corporate-sector and public-sector banks, which in turn is constraining future private investments (NITI AAYOG, no date). Reasons for stalled projects are many and include poor planning, management and implementation, and environmental impacts assessment processes that are long and not necessarily efficient.

Kumar et al. (2008) mentions that another reason for under-investment in large water infrastructure projects has been the growing argument on alternatives such as improvement of yield of

rainfed crops, small water harvesting schemes and virtual water trade. In reality, they should not be an either/or alternative: suitability and efficiency of each scheme should be considered according to the local conditions, except for virtual water that has long been challenged for policy and practical purposes (Wichelns, 2010).

The largest water infrastructure development at the national level at present, which would entail very high economic costs, is the interlinking of the major rivers of the country. In contrast to China's South-to-North Water Transfer, this is still at the prefeasibility and feasibility stages (Interlinking of Rivers, http://www.nih.ernet.in/rbis/india_information/interlinking.htm). Implementation of this mega project includes numerous infrastructure, in many cases construction of reservoirs for energy, food and water supply purposes. In spite of the benefits it can result in, it has faced very strong opposition because of its potential economic, social and environmental impacts and because it has been planned in the absence of pricing and non-pricing demand management instruments and strong local institutions that can ensure water will be used more efficiently. As in the previous case, as long as water resources management and governance do not become a priority at the basin, state and country levels, water transfers will never be enough to supply water in the necessary quantity and quality for the increasing number of uses and users.

3. Policies and management: a governance perspective

Water management practices in China and India, including infrastructure development and its financing, are not directly comparable. There are fundamental legal differences (including constitutional), as well as differences in political and institutional structures and mandates. Governance practices also respond to different requirements.

In China, the decision-making system is vested in the central government, even when there can be serious differences of opinion in numerous policy areas between the policy mandates at the centre and the policy implementation at the local levels that can affect every sector. In India, constitutionally the principal authority to manage water lies with the states and the role of the central government is advisory in nature. The central government can try to convince the individual states to adopt certain policies through economic incentives, such as additional funds that may be made available if certain policies are implemented or certain activities are carried out, but in reality, it has very limited influence.

Another fundamental difference is the political systems. In China, only one party is responsible for managing central, state, and municipal governments. In contrast, in India, the political party or parties in power in the central government (sometimes coalition governments) often do not control the majority of the states. If the central government suggests certain water policies, the opposition parties in power in the states and the cities can oppose them for valid, dogmatic or political reasons. For urban and rural water management and infrastructure development in India, political and institutional issues become even more complex. The state government may be managed by one party, and the city or municipal government may belong to a different one. Thus, municipal governments may disagree with state governments, contributing to conflicts and noncooperation. Since ruling parties at the three levels of governments often change every three to five years, long-term planning can become very challenging, to say the least.

In India, the three layers of government and water institutions also mean that the center does not always know how much the states are investing in water infrastructure, much less on what the municipal governments are doing. Most of the time, the states do not have consolidated data for current and future investments in water infrastructure, which are spread among various ministries, public-sector companies and municipal entities. For planning and decision-making purposes, it would thus be more efficient to have consolidated financial data on water infrastructure investments. One example of many is hydropower development, which can be executed by three autonomous public-sector companies that are independent of the water and energy ministries.

In China, there has been substantial public financing for infrastructural development, but the rate and the quality of infrastructure development still needs to be increased to the levels needed to sustain high rates of economic growth, consistent with reasonable quality of life in the long term. As mentioned earlier, the country's urgent need for infrastructure development has been the result of massive urbanization and industrialization. Much has been done, but the central and western regions of the country are still lagging behind the more prosperous southern coastal belt. The central government has been generally proactive in building planned infrastructure, targeting special economic zones and growth centers. In India, this type of initiative is mostly missing and infrastructure has more often been built in response to existing demand.

Private-sector investment in infrastructure (both foreign and domestic) is expected to play a strong role in China and India. However both governments need to plan more efficiently and effectively towards this end by increasing the level of competition and by promoting more transparency and accountability (KPMG, 2013).

Not only China and India, but many more governments around the world are increasingly turning to public–private partnerships and public concession models to help build and finance infrastructure initiatives. However, infrastructure investors are concerned about the reliability of government partners, deal structures, and the long-term viability of some investments. In the end, public–private partnerships and related approaches are only financing tools: policies, management, and governance practices will make them more or less useful for the countries. Numerous projects require replacement and the related expense of maintaining or upgrading these systems may force many agencies to delay or sacrifice new initiatives. Additionally, the potential impacts of climate change are changing the perception of public infrastructure. As mentioned by the Urban Land Institute/Ernst and Young (2013), the world is rethinking how infrastructure should work in a rapidly transforming global order, and there are no definitive answers yet.

3.1. The situation in China

More than 400 of the 660 largest cities are expected to face chronic water shortages, exacerbated by uneven distribution of water resources between the north and the south. Inefficient use of water resources and water pollution are anticipated to increase due to domestic, industrial, and mining uses as well as over-extraction of surface and groundwater. According to the Ministry of Housing and Urban-Rural Development, urban water and sewerage infrastructure systems are underinvested and understaffed, which make them largely insufficient in meeting both present and future demands. The ministry has estimated that the country would need some $1.03 trillion for urban public infrastructure and facilities between 2011 and 2015. Information for 2016 was still not available at the moment this analysis was written. Because water tariffs have been traditionally considered part of the public welfare structure, they are not expected to represent a source of stable financing (Yu, 2010).

In 2000, in the 10th Five-Year Plan, the country set ambitious targets to improve water quality by reducing chemical oxygen demand (COD) and reducing by 10% the amount of wastewater

discharged without treatment. However, according to the 11th Five-Year Plan for Environmental Protection, actual reduction targets reached only 2.3%. Surface water bodies continued to be heavily polluted (Shen, 2012).

A midterm evaluation of the 11th Five-Year Plan by the World Bank (2008) emphasized that pollution discharges decreased compared to the previous decade, thanks to the implementation of appropriate policy reforms and economic instruments; additionally, use of water for industrial, irrigation, and domestic uses was more efficient, and the industrial value added per unit of water consumed was higher (Table 6).

Some of the challenges the midterm review mentions include:

- Lack of institutional coordination and cooperation among different agencies, which has hampered progress, for example, in pollution control and water resource management–related activities.
- A focus on urban and industrial water sources, which may have resulted in lack of attention to non-point sources of pollution from agriculture, for which monitoring still had to be strengthened.
- Serious gaps in measurement and monitoring of surface and groundwater withdrawals.
- Fee schemes for irrigation water uses that were not enforced except in very few areas.
- Implementation of the plan would require timely availability of funding, primarily in the poorest areas in the country. A proposed possible solution was less dependency on the central budget and introduction instead of full cost recovery.

In 2011, the CPC Central Committee issued the No. 1 Policy Document on Water Resources Reform and Development (see Briefings on the Opinions of the State Council on Implementing the Strictest Water Resources Management System, http://www.china.org.cn/china/2012-02/17/content_24664350.htm; and USDA, 2011). The No. 1 Policy Document includes an entire section called "Accelerate Development of Water Conservancy Infrastructure in All Respects." The related investment was on the order of CNY 4 trillion ($ 618 billion in 2015 dollars) over the next 10 years in water conservation. It also required local governments to invest 10% of land sales revenue into rural water projects to use in projects such as consolidation of reservoirs and water-related infrastructure (KPMG, 2012).

The goals of the Plan include: develop extensive infrastructure for rehabilitation of major rivers; accelerate construction of flood detention zones; complete flood control projects during the 12th Five-Year Plan and construct urban flood control projects to higher standards; increase efforts for water resource allocation projects and complete key water projects and inter-basin and inter-regional water-transfer schemes to regulate water resources and assure water supply, the most important of which is the South-to-North Water Transfer Project. Mechanisms to increase public and private investment and strengthen financial support for water conservation were also considered priorities in the 2011 policy document.

The principles of this policy document have been incorporated into the 12th Five-Year Plan at the national, provincial, and local levels. Analysis mentions that environmental protection and pollution control will require further infrastructure development, mostly wastewater treatment plants to prevent, control, and treat pollution in major river basins (James, 2013).

The current 12th Five-Year Plan has a focus on high-quality economic growth. It aims at 7% annual GDP growth, more reliance on the domestic markets and less on exports, diversification of sources of finance, and private investment in infrastructure development (KPMG, 2013). Under this plan, China invested some $163 billion in water projects between 2011 and 2013 (compared to $115 billion during the entire 11th Five-Year Plan), focused on flood control works (37%), allocation of water resources (46%), hydropower monitoring (11%), and water and soil conservation and small hydropower (6%).

Wastewater treatment continues to be a priority, with investments in technologies, services, and solutions aimed to double to more than $4.54 billion. In the wastewater sector, participation of the private sector has resulted in greater numbers of wastewater treatment plants since 2002, and a more gradual growth in water treatment and supply, as well as in private water distribution networks. The most common model for wastewater project financing is build-operate-transfer, which has resulted in an increasing number of new projects. For instance, in Shanghai, a consortium of public and private companies was awarded a contract with the Shanghai Water Authority to provide wastewater treatment services. The plant serves 23.5 million people at a service fee of CNY 0.22/m^3 of treated wastewater and a minimum treatment level of 1.4 million m^3/day (ADB, 2010).

The plans also consider development of desalination, which is expected to grow by around 18% annually by 2017. Capacity is expected to reach between 2.2 million and 2.6 million m^3 per day thanks to investments on the order of $3.1 billion between 2013 and 2015 (KPMG, 2013).

The national goals for 2020 emphasize infrastructure development, such as works for flood control and drought relief; rational allocation and efficient use of water resources; water resources protection and safeguarding of the health of rivers and lakes; and reduction of irrigation water use while maintaining high yields. Sources of continued financing for water infrastructure will include fiscal funds (budgetary appropriations, construction funds, tariffs, and funds from land transfer used to develop farmland water infrastructure); financing (domestic and international loans and corporate bonds); and social funds (investments from companies and individuals) (PRC, 2012).

Table 6
The 11th Five-Year Plan Targets and Progress Related to Water Resources.

Item	Breakdown	2005	2006	2010 target	Government agency in charge
Reduce industrial water consumption	Water per unit of industrial added value (m^3/10,000 yuan, obligatory)	169 m^3	−7.7%	<115 m^3 (−30% in 5 years)	National Development and Reform Commission
	Industry water recycling rate	75%	n/a	(none)	
Irrigation Efficiency index	Irrigation efficiency index refers to the ratio of the water that could be used by crops against the total irrigation water	0.45	0.46	0.50	Ministry of Water Resources, Ministry of Agriculture
City water efficiency	Leakage from water distribution pipelines	20%	n/a	<15%	

Source: Adapted from World Bank (2008).

Investment in infrastructure to meet the future expected demand alone still requires, as suggested by Liu (2014), market mechanisms in financing, construction, and management of water resources; setting of procedures for efficient decision-making; improved supervision and management of investment funds; more efficient and effective institutions,and expansion of the right of the general public to information, participation and supervision. Policy reforms for water infrastructure are also needed in a number of areas such as loans, fiscal inputs from government budgets, mechanisms that promote competition, models to promote social capital and private-sector participation and institutional performance (KPMG, 2013) in addition to transparency and accountability (KPMG, 2014).

3.2. The situation in India

Water is highly political in India, where society is considered as highly inequitable, based on classes, castes, and genders (FAO et al., 2013). The country has the capacity to store about 200 km^3 of water and has an installed hydropower capacity of about 30,000 MW, its irrigated area of about 90 Mha, spatial and temporal rainfall variations, economic and population growth, and inefficiency in water use, in addition to policy, management, administrative, and infrastructure constraints, have resulted in a growing gap between water demand and supply and increasingly poor water quality (IDFC, 2011).

Years of underinvestment have left the country with poorly functioning infrastructure, like transit systems, power grids, and water services that are inhibiting its further economic and social development. Inadequate planning, poor coordination among sectors, ministries, and different levels of government, pervasive corruption at all levels, and political interference exacerbate this problem. The interplay between a federal constitutional structure and a multiparty system, in which coalition governments at the center need to coexist with opposition parties in various states, accentuates a culture of noncooperation and confrontation. Infrastructure development has consistently fallen short of targets and quality and this has hampered poverty alleviation efforts. At present nearly one-third of the population has no access to electricity. The rest often suffers blackouts and lacks access to clean water and wastewater management services (Xu and Albert, 2014). Progress in all sectors has been very slow, in terms of both physical progress and policy and regulatory instruments. These have contributed to an acute infrastructure shortage (Gulati, 2011). Infrastructure is now considered a national priority, but after years of neglect, the development and investment needs are very large.

Supply of water in urban areas is much lower in India than in other developing countries, and water availability has declined in numerous urban centers. Examples include Bangalore, where water was available for 20 h a day in the early 1980s, but only 2.5 h in 2006. In Chennai, water was available 10–15 h each day in the 1980s; this fell to 1.5 h a day by 2006. The reasons range from poor management to insufficient and badly operated and maintained infrastructure. Studies mention that people have had to pay an average of $3.90/month (capital costs included) to private vendors, when people who receive a water bill pay $2.22/month to the water utility (Misra, 2005). People normally cover the costs of electricity for pumps and/or boreholes, overheard storage tanks, and additional treatment to ensure the supply is clean. In slums, costs are higher in capital expenses, time, and inconvenience (World Bank, 2006). Insufficient and poorly managed infrastructure has had negative economic, social, and environmental impacts in several sectors for decades.

India has recognized that modernizing its infrastructure is a priority, and thus investment as a share of GDP has increased during the last three five-year plans, from 5.0% in the 10th Five-Year Plan (2003–2007) to 7.2% in the 11th (2008–2012) and 8.2% in the 12th (2013–2017) (Table 7). The sectoral investment in the 12th Five-Year Plan prioritizes electricity, followed by roads and bridges and telecommunications. The Indian government estimates that $320 billion needs to be invested in its infrastructure if current economic growth is to be sustained (Sharan et al., 2007).

During the 11th Five-Year Plan (2007–2012), the Planning Commission called for an estimated investment of $514 billion (in 2006–2007 prices, and at an exchange rate of INR 40 to USD 1) in 10 major infrastructure sectors. The estimated participation of the private sector was expected to be of 30% ($155 billion), higher than the 18% estimated during the 10th plan. Most of the private investment was expected to be in five sectors: electricity, telecoms, roads, ports, and rail (not in irrigation, water supply, or sanitation) (OECD, 2014; Planning Commission, Government of India, 2011).

In spite of what has been considered in the plan, there is the concern that, as previous experiences indicate, infrastructure projects will be delayed, with cost overruns of more than 100% in some cases (OECD, 2014).

The 11th Five-Year plan mentions that the country has been adversely impacted on average by 1–2 percentage points due to infrastructure constraints. High transaction costs arising from inadequate and inefficient infrastructure prevented the economy from realizing its full growth potential (Planning Commission, Government of India, 2008b). Based on data provided by the Ministry of Urban Development, the 11th Five-Year Plan considered that the funds required to provide urban basic services were on the order of $193.4 million.

India's 12th Five-Year Plan (2012–2017) (Planning Commission, Government of India, 2012) aims at investing $667.5 billion for infrastructure development over the duration of the plan to sustain a GDP growth rate of 9%. This is almost twice the investment proposed under the 11th Five-Year Plan in real terms, where the physical capacity targets were not met. The 12th Five-Year Plan acknowledges that the investment targets are very ambitious, but half of them are expected to be private-sector funds. Nevertheless,

Table 7
Investment in infrastructure in India (percentage of GDP).

Sector	Tenth Plan (2002–2007)	Eleventh Plan (2007–2012)	Twelfth Plan (2012–2017) (planned)
Electricity	1.5	2.4	2.7
Roads and bridges	0.8	1.3	1.3
Telecommunications	0.8	1.1	1.4
Railways	0.6	0.7	0.9
Ports	0.1	0.1	0.3
Airports	0	0.1	0.1
Oil and gas pipelines, irrigation, storage and water supply	1.1	1.3	1.3
Total	5.0	7.2	8.2
Public participation	3.9	4.6	4.2
Private participation	1.1	2.6	3.9

Source: OECD (2014).

as discussed earlier, there had been an important slowdown in investment for infrastructure to almost zero in the third quarter of 2014–2015. The reasons were the same: poor planning, management and implementation, and environmental impacts assessment processes that are long and not necessarily efficient.

It is argued that the pattern of inclusive growth at 9% per year can only be achieved if the infrastructure deficit is overcome and if investments are adequate to support higher growth and provide improved quality of life in urban and rural areas. At an annual inflation rate of 5%, this amount would reach $1,058 billion in 2010 dollars. In 2012–2013, the GDP grew at 5%, the lowest rate in a decade. This had a negative impact on all aspects, including infrastructure spending (Deloitte, 2014), which in return had a negative impact on GDP growth.

According to the Central Pollution Control Board (2010), estimated sewage generation from Class I cities and Class I towns (with at least 100,000 persons), which include 72% of the urban population, is 38,524 million liters per day, with a treatment capacity of approximately 30%. Five metropolitan cities have theoretical treatment capacity close to 100%: Hyderabad, Vadodara, Chennai, Ludhiana, and Ahmedabad. However, performance of the treatment plants is estimated to be only 19% of the installed capacity of 30%. The reasons for this poor performance are many, including the complexities and cost of expanding rudimentary or nonexistent sewer networks in many Indian cities; low coverage, as the total capital cost of establishing collection and treatment systems for the wastewater produced is much more than what the government intends to spend; poor maintenance, as operation and maintenance costs are too high for the local utilities to cover; frequent power cuts; and lack of trained personnel.

In 1985, the Indian government launched the Ganga Action Plan, one of whose main objectives was to construct wastewater treatment plants. Later on, the Ganga plan, and other action plans to clean highly polluted rivers, were merged under the National River Action Plan. A directorate was established under the Ministry of Environment and Forests. For the various clean-up activities for the Ganga, the Central Pollution Control Board estimated in 2012 that over $3,004 million had been spent. It mentioned that river basin studies have been carried out and polluted stretches have been identified in as many as 19 rivers. Water quality in the rivers has not improved for numerous reasons, some of them related to lack of treatment capacity (Government of India, 2013), others to poor planning and to implementation. With rapid urbanization and continuing inadequate pollution control, water quality in the rivers is widely expected to deteriorate much further.

Infrastructure spending has been financed almost exclusively by the public sector. In 2010, India needed $1 trillion for its infrastructure, with half of that expected to be private capital. The government established infrastructure debt funds as a new investment instrument to take pressure off commercial banks by providing long-term loans. The same year, the Reserve Bank of India and the Securities and Exchange Board of India promulgated regulations, and in 2012 and 2013 numerous financial institutions applied for and received approvals to establish the debt funds. Two different structures were introduced: nonbank financial companies and mutual funds. Water development, together with roads, airports, ports, power generation, power transmission, telecommunications, social infrastructure, etc., could now be funded with mutual funds (Lambert, 2014).

Toward the end of 2014, the usefulness of these instruments was questioned. They had been unable to achieve their objectives due to rigid regulatory requirements and lack of suitable projects (see *Market Realist*,http://marketrealist.com/2014/12/must-know-infrastructure-debt-funds-india/). The debt funds have the potential to reduce serious problems of long-term financing such as the $1.1 trillion of infrastructure financing needed for the 12th Five-Year Plan (Government of India, 2011). Nevertheless, for them to be implementable, numerous issues have to be addressed first such as rigid regulations, corruption, and lack of transparent legal systems to resolve disputes, land acquisition, and environmental clearances.

Decision-making, policy alternatives, and implementation processes, as well as investment mechanisms and participation of the public, private, and social sectors in a coordinated manner, in development of water infrastructure but also in every other subsector, can involve very complex processes. Not all progress or lack of it depends entirely on political will; it depends also on technical, administrative, and managerial systems that may be inefficient and ineffective, and on unsurmountable bureaucracies and inefficient institutions that seem almost too impossible to streamline and that can result in several degrees of vulnerability (Srinivasan et al., 2013). Governance problems require governance solutions and appropriate institutions that address the many social, economic and environmental constraints and consideration will have to be addressed in the short-, medium- and long-term.

4. Summary and conclusions

Infrastructure is central for economic growth and poverty reduction, and water and sanitation services are of the greatest significance for overall development and improvement of quality of life. China and India, the global rising powers, could become much larger forces in the global economy, but only if they are able to develop and maintain policies, institutions, and infrastructure that are supportive of growth (Wilson and Purushothaman, 2013). So far, they face enormous challenges to infrastructure development that need to be addressed from the policy, legal, institutional, managerial, technical, financial, and political viewpoints.

While soft (human capital and institutions) and hard (built) infrastructure development are not comparable between the two countries, for all the reasons discussed earlier, China does have an enormous and growing advantage over India. The policy, regulatory, and institutional environments have been more conducive in China than in India to develop and maintain infrastructure (World Bank, 2006). In the case of India, improving basic public services such as water supply and sanitation is still considered crucial to sustaining rapid growth.

Infrastructure development in both countries has responded to the pressures of economic and population growth, urbanization, and industrialization, as well as so-called globalization forces. In India, planning and implementation are still not ahead of project demand but mostly a response, even a reaction, to it (Kim and Nangia, 2008). Within the countries, there are still great imbalances that are impeding the development of the most disadvantaged populations socially and the poorest regions economically.

An important trigger for both countries to improve built, green and soft water infrastructure has been water scarcity due to either quantity or quality problems This, in turn, has impacted economic growth forecasts and the human and natural environments in general. So far, China and India have still not been able to fully enforce, regulate, and monitor their water-resources related policies. Solutions will have to be developed keeping in mind the growing social demands and also the associated fiscal burden. Improved monitoring will be essential to achieve this end.

Debate over the sustainability of China's rapid growth will continue, as will the momentum of its growth and externalities. Economic and population growth and urbanization are expected to be faster than in India, with the urban segment of the population likely to reach 60% by 2020. The population will reach its peak at 1.5 billion around 2033, at which time India is expected to surpass it. In the context of intensified urbanization, the continuous

growth of large and medium-size cities all over the world has resulted in a sense of urgency in most national and international policy circles because of resource use, and China and India are no exception. Well-planned, maintained, and operated infrastructure is essential for the delivery of and access to services, but its progress will depend on policy, management, governance and financial considerations that are much more complex to realize.

As mentioned by Estache (2008) and Rouse (2013, 2014), important parts of this are responsive institutions; appropriate policies and regulations; efficient public and private service providers; governance structures associated with infrastructure-project financing; economic and non-economic policies and incentives; auditing and financial accountability; equity, transparency, and fiscal considerations; and decentralization as a way to increase accountability and participation.

One could claim that long-term overall development is at a stake in India, because of poor and insufficient infrastructure, including its impacts on quality of life, economic prosperity, and long-term environmental sustainability. The country's responses to economic and societal needs have been not been sufficient yet, not realizing in practical terms the relevance infrastructural development has in multiple areas of national interest. A comprehensive and strategic plan to combat growing problems in all sectors, including water supply and sanitation, requires long-term plans and instruments from policy, implementation and political viewpoints. Infrastructure that is not dependent on political will and that relies on transparent and accountable processes will place the country on the right track in their continued search for sustained social and economic growth.

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Further readings

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