International Journal of Water Resources Development, 2014
Vol. 30, No. 1, 3–7, http://dx.doi.org/10.1080/07900627.2014.891927

Routledge
Taylor & Francis Group

Editorial: Infrastructure and development

(*Received 1 February 2014; accepted 4 February 2014*)

Introduction

Forecasting the future is a difficult task. However, one can predict with complete certainty that the world will change rapidly during the next four decades. Some of these changes may be predictable but others can at best be guessed in general terms. Some will be totally unexpected. For example, it can be predicted that the global population will continue to increase and is likely to be over nine billion by 2050. This increase will occur primarily in developing countries. Urbanization in the African and the Asian countries will increase significantly. Much urbanization has already occurred in Latin America and the developed world. Migration within countries and between countries will increase, bringing with it its own sets of challenges and opportunities. However, it is not possible to predict what new scientific and technological developments may occur in 2020, let alone in 2050.

With increasing population, changing demographic structures, urbanization, and phenomenal growth of the middle class in developing countries, the requirements for all types of resources will increase, unless the current resource-use processes and practices can be improved continuously and significantly. Agricultural productivity may struggle to keep up with the steadily increasing demands of a larger population and changing dietary preferences amongst the rapidly growing middle class. With rapid advances in communication and information technology, people's aspirations and expectations for a better quality of life will steadily advance all over the world. All these developments have to be squarely met amidst the increasing uncertainties imposed by many other complex and unexpected events over which individual nation-states will have at best somewhat limited, or even no control. Among these uncertainties are national and global economic growth rates; social, economic and political upheavals within and between countries; the extent of globalization and free trade, and their implications, positive or negative, on the countries and regions concerned; the magnitude and extent of climate changes; and rapid advances in scientific and technological knowledge. Viewed from any direction, future challenges are likely to be truly formidable, but then so are the likely opportunities if these can be handled properly and in a timely manner.

Infrastructure and development

While the future may be uncertain, one issue can be predicted with complete certainty. In the world as a whole, if the rising aspirations of the people are to be met, it will be essential to have better planned and managed infrastructure of all kinds but also to develop the human capacities and institutions to operate and maintain it properly in a cost-effective and timely manner. For countries to stay even in the same place in terms of socio-economic development and economic competitiveness with the others, they all will have to plan their infrastructure better, develop it faster and maintain it significantly better than

any time in human history. Without adequate infrastructure of all kinds, the development progress of countries will be seriously constrained. This is unlikely to sit well with the people who are expecting better standard of living and quality of life.

Numerous studies show the close interrelationships between a country's infrastructure and its economic competitiveness, and thus its long-term economic development. A country's economic development potential depends in a significant way on the extent and the quality of its infrastructure. In spite of this well-known linkage, the fact is that the world's infrastructure deficit has been increasing in recent decades. However, it should be noted that returns on infrastructure investment can only be obtained over the long term.

In 2006, the Organisation for Economic Co-operation and Development (OECD) estimated that the total new spending in infrastructure over 2010–2030 could be as high as USD 71 trillion (OECD, 2006).

Nearly a decade after this study was completed, the methodologies used leave much to be desired. A year later, in 2007, Booz Allen Hamilton estimated that to "modernize obsolescent systems and expanding demand" would require investment of USD 41 trillion between 2005 and 2030. The report also warned, "Much of America's critical infrastructure is failing, threatening our economic growth, national competitiveness and even national security" (Doshi, Schulman & Gabaldon, 2007).

Booz Allen Hamilton's estimates of necessary infrastructure spending by sector were:

- Water and wastewater: USD 22.6 trillion
- Power: USD 9.0 trillion
- Roads and railways: USD 7.8 trillion
- Airports and seaports: USD 1.6 trillion.

It is interesting to note that this report considered that water and wastewater investment spending would be a little over 50% of the required total.

The World Economic Forum estimated in 2010 that over the following 20 years the infrastructure deficit was likely to be USD 2 trillion per year.

The difference between the OECD's USD 71 trillion and Booz Allen Hamilton's USD 41 trillion is very significant. However, global estimates of any kind leave too much range for errors. They depend on the assumptions, quality of data available and analyses, and the experience, knowledge and understanding of the analysts (Ashley & Cashman, 2006). Thus, like all global estimates, these should be considered very approximate. The fact remains that the global infrastructure investment needed in the next 20 years will probably be somewhere between USD 40 trillion and USD 75 trillion. Whatever the exact amount, the fact remains that an enormous amount of investment will be necessary to ensure that the necessary infrastructure is developed and that it is properly maintained.

Water infrastructure

There are three major issues that the world is now confronted with in terms of water infrastructure. First, the population in all developing countries has increased significantly in the recent decades, and the growth in infrastructure has not kept up with the new realities. In all African, Asian and Latin American developing countries, over the recent decades, infrastructural developments have lagged far behind what was needed because of increasing population growth, urbanization, constantly expanding economic activities and higher aspirations of their people. Politicians and bureaucrats have mostly not realized the need and importance of infrastructural development and proper management to cope with new demands and catch up with the previous backlog. Thus, infrastructure

development and adequate maintenance often did not receive the priority they deserved from planners and political decision makers.

Second, good and comprehensive planning for water infrastructural development has been rare in most countries. For example, countries have built numerous water and sewage treatment plants without considering where trained and experienced operators may come from. China recently found that over 25% of its newly constructed sewage treatment plants were not working because the pipelines bringing wastewater to the plants could not be completed in time (Lu, 2014). China also mandated suddenly in 2013 that its nationwide water institutions would henceforth be measuring 106 water quality parameters, compared to only 36 before. No serious thought has been given to whether laboratories are available all over the country to sample and measure these parameters or qualified and trained personnel could be recruited to staff them adequately.

While the situation is very similar in other developing countries, the level and extent of the problems vary from one country to another, and then often from one part of the country to another. However, the fact remains that good planning in the area of water infrastructure has mostly been conspicuous by its absence.

In addition, inter-institutional coordination between water and water-related institutions leaves much to be desired. For example, as Pandit (2014) points out in his article in this issue, environmental clearance of major hydropower and irrigation projects in India often takes years – sometimes decades. And, sadly, all the emphasis is on clearance of the projects. No one bothers to check whether the environmental mitigation measures that may have been a condition to have the project cleared have ever been implemented by the public- or private-sector institution constructing the project. In fact, one would be hard pressed to find even a single major water project which the Indian Ministry of the Environment has audited to see to what extent the conditions that were specifically imposed with respect to environmental clearance were ever met. Thus, environmental clearance often becomes a paper exercise whose beneficial impacts become somewhat dubious. Regrettably, the situation is very similar in most developing countries, as well as developed countries.

Third, a major problem with water and sewerage pipes is that they are almost all underground, and thus not visible to the population or to policy makers. Thus, whenever municipalities face a cash crunch, which is frequent, proper maintenance is deferred indefinitely. Consequently, the quality of water service delivery starts to suffer because of the absence of proper timely maintenance.

If the case of the United States, the world's most important economy, is considered, the situation of deferred maintenance and underinvestment can be graphically illustrated. The American Society of Civil Engineers has been carrying out comprehensive assessments of the country's major infrastructure categories since 1998. The report uses a simple A-to-F type of school report card format in considering current infrastructure conditions and requirements. It considers eight criteria for grading: capacity, condition, funding, future needs, operation and maintenance, public safety, resilience and innovation.

Since 1998, the grades have been very poor, in fact near failing, averaging only D's because of delayed maintenance and underinvestment in most categories. In its latest report (2013), the society gave bridges a C^{+}, ports a C, dams a D, drinking water a D, inland waterways a D^{-} and wastewater a D. Not surprisingly, water mains burst an average of 250,000 times a year, which increases water losses. Unfortunately, even with the prevailing historically low interest rates, there are no encouraging signs that infrastructure underinvestment and deferred maintenance are likely to change in the foreseeable future.

The situation is worse than the USA in many other countries. If we consider the case of China, in recent decades it has built infrastructure at a break-neck speed, but it has not been

enough to meet the national requirements. Chinese infrastructure development has been truly frantic, especially when compared with other Asian countries. For example, in 2009, India had 6000 km of 4-lane highways. In contrast, during only the preceding 10 years, China had built 35,000 km of 4-to-6-lane highways. Each month, China adds nearly the total electricity generating capacity of Bangladesh, a country with 155 million people (around 11% of the population of China).

Even after these developments, China has much to catch up with. For example, its railway network today is shorter than that of the United States in the 1880s. Around 85 cities in China of more than 5 million inhabitants still do not have mass transit systems.

Urbanization will create more and more demand for infrastructure in Asia, especially in countries like China, India and Indonesia whose economies are developing fast. By 2030, an additional 650 million people in Asia are likely to have become urban dwellers. This is estimated to require an additional infrastructure investment requirement of USD 11–12 trillion, equivalent to almost 80% of the region's current GDP (Man, 2013).

Regarding water infrastructure, an important conceptual problem between developed and developing countries is the difference in extreme seasonality of rainfall. For example, if a monsoon country like India is considered, some 80% of its annual rainfall occurs in about a total of 80–120 hours (not continuous) during the rainy season. Hence, the main problem all the monsoon-climate developing countries are facing is how to collect and store this immense amount of rainfall in this short period of time so that enough water of the required quantity and quality is available throughout the year, as well as over varying years, for domestic, industrial and agricultural uses, hydropower generation and other uses. Policy makers, bureaucrats and even water professionals are not aware of this fact or of its implications in terms of water management.

All developing countries which receive such seasonal skewed rainfall have to consider increasing their storage capacities if they wish to achieve water security in the foreseeable future. Sadly, developed countries in temperate climates, and a few others in semi-tropical climates like Australia, which have much more uniform rainfall, have significantly greater storage capacities than any developing country. For example, the United States has a storage capacity of 6155 m^3 per person, and Australia 4733 m^3 per person. In contrast, China has around 2500 m^3 per person, and Brazil 2155 m^3 per person. India has less than 10% of the storage capacity of China, at 225 m^3 per person. Ethiopia and Pakistan have even less.

Lack of storage and the resulting water insecurity can be graphically illustrated by the water situation of one of the rainiest cities of the world, Cherrapunji, India. The average annual rainfall is 12,000 mm per year. In spite of this torrential rain, Cherrapunji has severe water shortages during non-monsoon months because of low storage capacity.

Knowledge and technology have been available for years as to how to store water efficiently and effectively to ensure against intra- and inter-annual water availability. Availability of investment funds is often not the problem. Lack of political will, institutional incompetence, public apathy, absence of serious media scrutiny, and pervasive corruption in the capital-intensive water sector have all contributed to water unsustainability.

Mismanagement and bad planning of infrastructure have also created numerous problems in many different countries. For example, the Supreme Court of India expressed its intense disappointment with water infrastructure expenditures which did not appear to have any impact. It said on 10 October 2012: "It is unfortunate that huge public funds were spent" to clean up the Yamuna River, yet the "the pollution of Yamuna has increased by the day" (Biswas, 2012).

Similarly, China spent USD 112.41 billion on water infrastructure between 2006 and 2011, and yet much of the country's water remains undrinkable. Funds have to be targeted better to produce the desired results.

Concluding remarks

While all over the world there is a deficit of water infrastructure, constructing it without good and comprehensive planning is unlikely to reduce the continuing deficit. Equally, there must be capacity in the country to operate and maintain it properly and in a timely manner. In much of the developing world, proper operation and maintenance seldom receives adequate attention. Thus, often a vicious cycle of build–neglect–rebuild develops which is not only expensive but counterproductive. This process seldom provides long-term sustained benefits.

Acknowledgements

Some of the papers for this infrastructure issue were specially commissioned for a special session on water infrastructure during the 2012 Singapore International Water Week (SIWW). It was sponsored by the Lee Kuan Yew School of Public Policy, SIWW and the Third World Centre for Water Management. The majority of the papers were submitted for possible publication in this journal.

On behalf of the *International Journal of Water Resources Development*, we thank the numerous anonymous peer reviewers who unstintingly helped us to review all the papers received during 2013 within the stipulated period of four weeks. Thanks to their efforts, the quality of all the papers published remains very high. We are most grateful to them for their insightful peer reviews.

Finally, here are our current most-cited articles (2013 Web of Science citations of papers published in 2011 and 2012). As promised, the main authors of these papers will receive free online subscriptions to the *International Journal of Water Resources Development* for 2014:

Robert J. Diaz and Rutger Rosenberg, "Introduction to Environmental and Economic Consequences of Hypoxia", Volume 27, No. 1 http://www.tandfonline.com/doi/full/10.1080/07900627.2010.531379

Kevin Parris, "Impact of Agriculture on Water Pollution in OECD Countries: Recent Trends and Future Prospects", Volume 27, No. 1 http://www.tandfonline.com/doi/full/10.1080/07900627.2010.531898

References

American Society of Civil Engineers. (2013). *Report card for America's infrastructure*. New York, NY: ASCE.

Ashley, R., & Cashman, A. (2006). The impacts of change on the long-term future demand for water sector infrastructure. In Organisation for Economic Co-operation and Development (OECD) (Ed.), *Telecom, land transport, water and electricity* (pp. 241–322). Paris: OECD.

Biswas, A.K. (2012, November 9). *Yamuna, Ganga cleanup: Fact or fiction.* Dainik Jagran.

Doshi, V., Schulman, G., & Gabaldon, D. (2007). Lights! Water! Motion! *Strategy+Business*, *46*, 1–7.

Lu, S. (2014). Water infrastructure in China: The importance of full project life-cycle cost analysis in addressing water challenges. *International Journal of Water Resources Development*, *30*, 47–59. doi:10.1080/07900627.2013.847760.

Man, R. (2013). *Asia infrastructure shortfall*. Hong Kong: HSBC.

OECD (2006). *Infrastructure to 2030: Telecom, land transport, water and electricity, Vol. 1*. Paris: OECD.

Pandit, C. (2014). Environmental over enthusiasm. *International Journal of Water Resources Development*, *30*, 110–120. doi:10.1080/07900627.2013.871480.

World Economic Forum (WEF). (2010). *Positive infrastructure: A framework for revitalizing the global economy*. Cologny: World Economic Forum.

Cecilia Tortajada[a] and Asit K. Biswas[b]

[a]*Third World Centre for Water Management, Mexico;* [b]*Lee Kuan Yew School of Public Policy, Singapore*