Water, Food and the Economy

E.M. VINNARI

Postdoctoral Researcher
Turku School of Economics
Rehtorinpellonkatu 3
FIN-20500 Turku, Finland.
Email: eija.vinnari@tse.fi
(Corresponding author)

H. FREDERIKSEN

Consultant, Water Resource
Eugene, Oregon, U.S.A.
Email: haralddf@comcast.net

ABSTRACT

Water and the economy have always been engaged in a two-way interaction. Almost all the great civilisations in the world formed around water, which has been essential not only for supplying drinking water but also for sustaining agriculture, energy production, trade and transport – the foundations of economically and culturally thriving societies. This article presents and discusses the papers presented at the 5th IWHA Conference under the theme 'Water, Food and the Economy'. The papers and presentations were specific to food security; land and water resources management and policy; the economic significance of watercourses in energy production, transport and economic development; the intertwined nature of water infrastructure projects and politics; and the management of extreme weather phenomena. The article closes with a few remarks regarding the theme papers and topics within this area that should receive greater attention in future efforts.

KEYWORDS

Water, food, economy, resources, IWHA

Environment and History **16** (2010): 195–212.
 doi: 10.3197/096734010X12699419057296

1. INTRODUCTION

Water and the economy have always been engaged in a two-way interaction. Almost all the great civilisations in the world formed around water, which has been essential not only for supplying drinking water but also for sustaining agriculture, energy production, trade and transport – the foundations of economically and culturally thriving societies. Today, agriculture is the largest consumer of global freshwater resources, while trade and transport of goods still relies to a large degree on shipping by sea. Countries are also increasing the quantities set aside for the environment – in California the allocation is greater than the quantity consumed by irrigation.[1] Concerning energy, hydropower accounts for a fraction of the global energy supply, but its share is increasing due to the expanding energy needs of the rapidly growing economies in Asia and Latin America. The other side of the coin is that economic development and the exponential growth of the global population have greatly increased human demand for water, thus placing a burden on this limited resource and the environment. Overdraft of aquifers is becoming widespread and critical in many regions as modern well construction allows access for all users: expanding urban areas, per capita use and agriculture.

The above considerations form the background to the IWHA 2007 Conference theme 'Water, Food and the Economy'. The aim of this article is to present and discuss the papers presented pertaining to that particular theme, the topics of which cover food security; land and water resources management and policy; the economic significance of watercourses in energy production, transport and economic development; the intertwined nature of water infrastructure projects and politics; and the management of extreme weather phenomena. The cross-cutting theme of these papers, expressed both explicitly and implicitly, was the importance of learning from historical practices and experiences and applying that knowledge to understand and develop present practices as well as to plan for the future. As a particularly poignant example, we should like to cite the papers presented in a session on Dutch water management by Bosch, Disco, Toussaint and Mostert. The variety of papers presented in the session illustrates the vast amount of information offered and the potential usefulness of considering complete historical records, of water management in a particular setting and/or of a particular aspect of water management by a government. This, in the editors' view, is an important feature and the major contribution of the IWHA Conference and its materials, since such an underlying perspective is offered by few international associations.

After this short introductory section, this article proceeds to summarise and present the key findings of the ten conference sessions dealing with aspects of water and the economy. No comments or critiques are offered on individual papers. The article closes with a few remarks regarding the theme papers and topics covering this area that should receive greater attention in future efforts.

Attached is a list of references headed by the CD containing the papers in their entirety as well as the abstracts of all Conference papers.[2]

2. ASPECTS OF WATER, FOOD AND ECONOMY

2.1 Water, agriculture and food security

The world's agriculture depends on water and accounts for an average of 70 per cent of global freshwater use (Fig. 1). The production of food crops and animal fodder alone is enough to put pressure on the unevenly distributed and tightening water resources; yet further complications have emerged as the accelerating intertwined use of food crops for fuel has suddenly and substantially affected the food supply, inflation and the choice of whether to utilise farm land to produce alternative fuels or food. Furthermore, as the global population expands, increased efforts are needed in order to reduce poverty and guarantee access to water for food security while simultaneously preventing ecosystem degradation and expanded use of land and water resources. According to the latest World Development Report[3], about 75 per cent of the world's poor live in rural areas where opportunities for livelihood outside small-scale subsistence farming are limited. Therefore, echoing the Green Revolution of the 1960s, which focused on increasing crops and resulted in the construction of large scale irrigation systems, calls have recently been made for a 'Blue Revolution', which would shift the focus back to small-scale systems and integrate land management into water resources management.

A concept closely related to the Blue Revolution is Irrigation Management Transfer (IMT), which basically stands for passing more irrigation management responsibility from the government to lower levels of system management, such as water user associations or other non-governmental organisations.[4] Since the functioning of such informal systems is to a large extent based on networks and mutual trust, they build up social capital which may, in the longer term, accumulate enough to expand cooperation from local to national level. Therefore, as an institutional solution, the widespread application of IMT could ultimately lead to improved production and more efficient management of water resources.[5] Regarding technical solutions, greater attention should be given to local farming conditions and small scale farming that would lead to gains in food production. In Sri Lanka, for instance, root crop mulching and irrigation with harvested rainwater have resulted in significantly larger crops without increasing the amount of water used.[6]

2.2 Integrated water resources management

Integrated Water Resources Management (IWRM) is currently a buzzword carrying several different meanings. An oft-cited source[7] defines IWRM as a

holistic approach which seeks to coordinate the management of water, land and other natural resources in order to maximise economic and social welfare but without compromising the sustainability of ecosystems. The principles behind IWRM are generally considered to have emerged along with the concept itself in the 1990s, but in fact their intellectual history actually harks back to the United States of the 1920s, and they also share significant similarities with more generic management concepts such as Strategic Planning. Theoretically speaking, IWRM has been institutionalised in global discourses but in practice it is difficult to establish what constitutes actual policy transfer and what constitutes rhetoric transfer. An examination of the history of water resources management could provide further insights and help in bridging the gap between the discursive and normative functions of the concept.[8] Viewed through the lens of hydropolitical history, the inconsistencies of the IWRM concept suggest that it is simply old knowledge in a new package, thus leading to the question of whether the term provides any new tools to resolve water management issues.[9]

In practice, the IWRM principles have been advocated as almost a panacea for the problems of water management, and consequently serious efforts have been made to implement them, especially in developing countries. In Benin, for instance, the poor coordination of the interactions between various water sector decision-making bodies and the scant attention paid to water and sanitation have caused the government to implement IWRM on the national and, more recently, on the municipal level. Preliminary results of the latter initiative suggest that increased attention is being given to IWRM in municipal development plans and that there is increased awareness of the various factors affecting water availability or quality and interest in inter-municipal cooperation, but the process itself has been quite lengthy.[10] In India, recommendations for the application of IWRM are associated with the need to create buffers or resilient interfaces to absorb the shocks caused by increasingly harsh and extreme climatic changes as well as to tackle present and future challenges to water resources. It is argued that other low-income countries should also give priority to issues of integrated management of water and soils, encouraging active participation of local people.[11]

2.3 International experiences of water management

An international overview of long-term developments shows that land and water management issues have common features but are also very much context-dependent. In the United States, the construction of the Californian aqueduct system was in part triggered by urban growth in the metropolitan areas of San Francisco and Los Angeles. Currently, the water used in Los Angeles is obtained from three different aqueducts, each several hundreds of miles long, while San Francisco's water supply comes from an aqueduct that originates in a controversial dam adjacent to Yosemite National Park. The California water project eventually resulted in environmental problems, such as dust storms and ecologi-

cal neglect, as well as ownership disputes involving lawsuits, court decisions and strict water use regulations. Changes in water rights and regulations have more recently been introduced, but much more is needed especially in terms of water recycling and equitable allocation to all user groups.[12]

Enormous population growth is also creating difficult water problems in Iran, which has started to look back in history for more sustainable methods. The pre-modern water supply of the country was founded on qanats, intricate systems of underground tunnels and vertical shafts. In ethical terms, the qanats were rooted in Zoroastrianism and Islam, both of which fostered communal involvement, respect towards nature and avoidance of resource overexploitation. The community-based ethics of the qanats was replaced in the 1960s by the mechanistic worldview of the modern industrial period, which resulted in the construction of private individual wells and large dams and related human interactions becoming dominated by economic factors. In recent years, the industrial paradigm has begun to receive criticism and community participation has again been brought to the forefront. It is now more widely believed that the ethics, ownership arrangements and operational features of the traditional systems were more compatible with the ecological and social requirements of Iran and should therefore be revitalised.[13].

Since the Second World War Chile has experienced population and economic growth that has strained the country's available water resources. Chilean water policies from the mid-twentieth century onwards were examined through two case studies, which focused respectively on the consequences of neo-liberal projects on remote indigenous South American communities and protective water management policies on Easter Island, a tiny Pacific island characterised by a complete lack of rivers, creeks or springs. On the mainland, a series of legislative approaches to water management have not been fully adequate in resolving ownership and usage rights disputes between the indigenous population and corporate interests, or in integrating the ecosystem into the considerations. On the other hand, on Easter Island, where neo-liberal water governance models have not been introduced, restrictions on growth have better matched needs with available resources.[14]

In a Nepali mountain village, lessons learned from ancient practices are underpinning social and economic changes. Until recently, the villagers had to fetch their household water from a well located half a kilometre down the mountain, the two-way journey consuming three hours of productive time each day. The village committee then introduced a new system, which is based on the traditional method of harvesting rainwater during the Monsoon season and storing it for use in the dry season. Following the application of this technically simple and cheap system, the water supply problems of the village have to a large extent receded, while easier access to supplies has allowed more time for other activities, including higher school attendance.[15]

In the case of the Netherlands, the problem has never been the scarcity but rather the overabundance of water, even to the extent that the struggle against excess water united the people into a nation. The country's mostly below-sea level location necessitates careful water resources management, which is why regional water boards mandated with this task were already established in the 1100s. Faced with the powerful threat of flooding, the board members were compelled to disregard their disputes and join forces for a common cause. This consensus-based model of cooperation caused a further decentralisation of government responsibilities to local level bodies and even today forms the foundation of the Dutch way of conducting politics.[16]

In New Zealand, another water-abundant country, the Maori people have historically perceived themselves not as the owners but as the guardians of rivers and sea coasts, which is why today they are very much concerned about the protection of water courses. Overfishing and other growing pressures on resources, coupled with pollution, have triggered protests, especially against large corporations. As a consequence of these persistent protests, the Maori, who were previously excluded from water related deliberations, have been included in the official bodies and institutions involved in water management and decision-making.[17]

2.4 Water, trade and transport

Rivers, oceans and lakes have traditionally provided an important and cheap means of transporting people and goods. Rivers are especially significant in geographically large countries such as India. In the mid-1800s a British engineer named Cotton planned to link all the major rivers in India by a canal circling the country. His aim was not only to facilitate transportation but also to augment supply in the most water-short basins during regional droughts. Cotton's ambitious plan failed due to unavailability of the immense funds required and the more influential proponents of the technologically superior railroads. Yet, the lack of support from the British colonial government was compensated for by the references to the philanthropic nature of Cotton's plans by, for instance, Florence Nightingale, who argued that the implementation of the canal would have greatly advanced the public health situation in India, and Cotton's Indian biographers, who portrayed the plans as anti-colonial efforts. Much later, the newly independent Indian state made Cotton an emblem of improving citizen welfare, which explains why the concept of linking Indian rivers surfaces from time to time even today, even though it is not financially or politically viable. Such philanthropic notions need to be decoupled from large projects in order to channel funding to more viable and efficient small-scale projects.[18]

In South Africa, a system such as the one planned by Cotton is actually working, although on a much smaller scale. South Africa has one of the densest networks of rivers and linking water conveyances, which makes it difficult

to differentiate between natural and artificial dynamics. Terms such as 'techno nature' or 'hybrids' have been used by scholars in different spatial and historical contexts to describe such systems. The South African system allows for efficient utilisation of its resources to best meet its social and economic needs – thus supporting the view that major river developments can allow greater economic growth while accommodating environmental needs.[19]

Seas and oceans are other important routes for transport. The Southern routes from Europe to Africa and Asia were discovered already in the fifteenth and sixteenth centuries but the northern route from the Atlantic to the Pacific remained unopened until a Finn, the explorer A.E. Nordenskiöld, first navigated the Northeast Passage in 1878. He succeeded in opening a sea route between Europe and Siberia, a vast area known for its enormous, then almost untouched, reservoir of natural resources. Although the significance of Nordenskiöld's efforts to world economy and trade soon faded due to the construction of the Trans-Siberian Railway, the passage has remained an important channel to the Arctic waters long believed to be inaccessible.[20]

Water is associated with trade not only as a medium of transport but also as the drinking water utilised on board. Distillation of sea water for drinking purposes on protracted sea voyages had been investigated as early as the 1630s but was only accepted as a useful technology in the 1800s. During this long period of development, two disputes about intellectual property rights arose sixty years apart. The question was raised whether rapid development of technology is truly encouraged more by patent protection or by open scientific debate. It was also pointed out that in the cases observed, patenting did not prevent scientists from forgetting certain findings and rediscovering them half a decade later.[21]

2.5 Hydropower and dams

The most common reasons for constructing dams on rivers are to provide water for irrigation, industry and household use; to produce hydropower; or to control floods. While dams provide all these benefits to the economy, they also alter river flows and adjacent ecosystems as well as affect human settlements, livelihoods and rights of access to water. It has been estimated that up to 45,000 dams had been built by the end of the twentieth century, most of them after the Second World War.[22] The development of hydropower was basic to the establishment of many cities and industries, but the scale of the projects has been increasing, from early installations to drive sawmills and grind flour to the mega-scale hydro-electric projects of more recent times (Fig. 2). Hydropower currently accounts for only 2.2 per cent of the global primary energy supply and 16.0 per cent of electricity production.[23] However, during the last three decades hydropower production has more than doubled as a response to the energy needs of rapidly expanding economies, especially in Asia and Latin America.

The variety of political, economic, environmental and cultural aspects associated with damming and hydropower guarantee that it will continue to be a topic of intense discussion and debate. This was also noted in the two conference sessions, which covered projects in diverse countries. In Congo, the Grand Inga hydroelectric scheme, which has been planned since the 1930s, would involve diverting the entire lower part of the Congo River through generators in order to produce 39,000 GW of energy. The environmental significance of the Grand Inga is notable, as it could replace all African thermal plants, support failing hydroelectric plants and eliminate the need for new power dams – thus reducing the continent's impact on global warming and allowing some rivers to be returned to their natural states. Yet these continent-level benefits might be offset by the project's locally harmful effects, which include damage to the ecosystems of the lower Congo and adjacent regions and the permanent clearing of forest for power lines. It is feared that if developed in accordance with competitive market principles and with extensive private sector participation, the Grand Inga could end up fulfilling the colonial dreams of ending European power shortages.[24]

The use of waterpower has also caused conflicts in Finland. The dawn of large-scale industrialisation at the end of the nineteenth century brought along a large number of energy-intensive factories which required the right to dam rivers in order to secure power, leading to conflicts with other stakeholder groups such as fishermen, farmers, boatmen and timber-floaters. Various conciliation efforts were made by the national government, but eventually the state ended up promoting hydropower as a way of implementing its country-wide electrification programme in the early 1900s.[25]

Concerns over sustainable management of water resources and other environmental aspects have started to gain ground in discourses regarding hydropower and damming. In Norway, hydropower has greatly contributed to the economic development and modernisation of the state. However, the rapid growth of industry combined with the lack of consideration for any other than financial benefits provoked criticism from various interest groups. This led to the formation in the 1970s of a river systems protection plan, which stressed the importance of protecting the natural state of watercourses by curtailing the use of hydropower. A significant step was taken in Western Norway in 2005, when the construction of a hydropower plant was rejected in favour of establishing a national park.[26]

Sustainability considerations have also emerged in Romania, where the re-introduction of traditional water wheels is being considered. Water wheels were in use from the Middle Ages until the early twentieth century but were replaced by hydropower plants. New types of water wheels are currently being developed, instigated by the increasing need for renewable energy sources.[27]

Damming need not be associated with hydropower in order to create conflicts. In South Africa, home to four of the five largest reservoirs in the world, human development and poverty elimination objectives often take priority over the

wellbeing of the natural environment. The construction of two dams in north-eastern South Africa in recent years evoked the concern of civil society as the rivers in which they are located flow through the Kruger National Park. The South African government, for its part, has decided to cooperate with industry to secure the attainment of its development goals. It was stressed that in situations like that it is very difficult to find a solution satisfactory to all that considers the various interests at stake. Therefore careful attention needs to be paid to planning and consultation with conservation authorities when using rivers for development purposes. Furthermore, constant monitoring of the interaction between humans and nature should be a fundamental part of integrated water resources management strategies.[28]

In Southeast Asia, the livelihoods of millions of people depend on the Mekong River, which originates in China and flows through six countries on its way to the South China Sea. Currently the hydrology of the Mekong is influenced by human-caused deforestation, embankment and urbanisation, irrigation and damming. In the future, the largest human effects on the river's hydrology will be caused by damming and large-scale irrigation, due to the escalating energy and food requirements of the growing population, while impending climate change is expected to cause the largest non-human impact. Thus far the assessments of the future hydrological impacts of the Mekong basin development plans have been rather piecemeal, which is why there is an urgent need for a holistic and objective cumulative impact analysis.[29]

Some countries have already reached the stage of removing dams in an attempt to restore the natural conditions of the altered riverine ecosystems. When such removals are contemplated, misunderstandings often arise between the engineers/natural scientists, who focus on the physical and biological changes of the removal, and the economists who attempt to assess these changes in economic terms. For the purpose of understanding these interlinked complications, a two-dimensional taxonomy of dam removal was introduced.[30] The physical dimension of the taxonomy is associated with the size, function and location of a dam, the impacts of sediment movement and the dam being a liability rather than an asset, whereas the economic dimension involves the difficulties faced when translating these changes into monetary values: the uncertainty of the removal benefits; the non-market character of the changes; the effect of positive or negative externalities on third parties; whether to define the scope of the analysis as local, regional, national or global; and the projection of the costs and benefits of the removal over a long period of time.

2.6 Water, economy and politics

The interconnection of water technology and politics cannot be avoided. In the late nineteenth century, the structure and sovereignty of Ireland were undergoing a notable change. The construction of the Silent Valley reservoir close to

Belfast was delayed by intertwined political and technical obstacles, in which the engineering difficulties associated with building the reservoir were used strategically in the land ownership disputes between the recently separated South and North of Ireland.[31]

In Japan, the plans to manage the Toyama River bore significant consequences for national politics since the 1860s. Politicking led to the government's neglect of the river and the resulting impacts on people, and the situation remained the same even after the mid-1800s when the 'modern' period of Japan's history commenced. As the Toyama prefecture needed to negotiate with the state about funding for flood control projects, practices and asymmetrical relationships emerged which resulted in the prefecture's greater dependence on central government financing on one hand and political irrelevance on the other hand.[32]

In India, the colonial state had a key role in the management of water channels. Three factors can be identified in the career of the colonial state that were significant in devising the regime of control over natural resources: the diffusion of scientific developments and technological improvements from the metropolis into the colonies; the expansion of the area controlled by the East India Company and the consequent opportunities for conceiving large-scale projects; and the utilitarian doctrine which justified water management policies on the grounds of expected social and economic benefits. The centralisation of power was the critical factor defining the relationship between the colonial regime and its water resources, with the concentration of knowledge and power allowing for more ambitious objectives while changing the nature of the resource towards the new modern civilisation that the colonial state was striving to introduce.[33]

In Central and Eastern Europe, the construction of the Gabčikovo-Nagymaros dam between Hungary and what was then Czechoslovakia was raised in political negotiations starting at the end of the 1950s and agreed upon two decades later. By the end of the 1980s, the dam and its construction had been contested by various interest groups and raised an international scandal. However, on opposite sides of the border, the dam was politicised and took on highly different symbolic value. While in Hungary the dam raised mass protests, Slovaks supported the process as an act of political and cultural self-definition.[34]

2.7 Benefiting from archives

As stated in the introductory section, archives and other historical records offer ample material and information for the study of water management in a particular setting and/or of a particular aspect of water management by a government. For instance, the centuries-long history of the Netherlands' wrestling with severe water problems, particularly the potential widespread inundation coupled with river transportation, provides a rich history of several aspects of water management. The Netherlands has devised a range of institutional, technical and policy approaches to its water management that effectively meet its economic

and social needs. An analysis of the long period of flow regulation and channel improvements on the river Meuse in the province of Limburg illustrated the local institutional changes and the politics practised in the early 1900s, shows that the long drawn out process should be interpreted in the context of state-formation and central-regional government dynamics in the Netherlands. The Limburgers had felt insulted by the neglect of the Meuse and actively demanded improvements to flood control and navigability; a process which also created an opportunity for identity formation.[35]

Institutional and technical evolution at the national level in the Netherlands at the turn of the nineteenth century produced a strong national capability to support the existing provincial and local bodies in their work. The establishment of a national river management level can be seen as the onslaught of a new central-government engineering elite against the existing regional and local structures for flood and dike management. This permitted the introduction of the concept of 'national commons' areas and facilities, important features today for meeting environmental objectives which are not possible under a strictly local focus.[36]

Rapid advances in the technical and operational aspects of water management were made throughout the nineteenth century. An examination of the history of hydraulic knowledge in the Netherlands, including increasing levels of protection against inundation in both the interior and along the coast, shows that river management remained largely an empirical exercise throughout the nineteenth century, while coastal flood management became a central government activity only at the beginning of the twentieth century.[37] In recent years, international flood management practices have improved. This is usually credited to international organisations, but it can be argued that industrial transformation, regulations imposed by the European Union, and other contextual factors are in fact equally important.[38]

Maps and other archival material may also be of great benefit for present-day planning and management of irrigation systems as shown by the case studies from Morocco, Spain and France.[39,40]

2.8 Learning from the history of extreme climatic phenomena

Storms and related floods pose ever greater dangers to water supply and waste treatment infrastructure as well as damage to human life and property. These dangers are exacerbated by urban development on flood plains, lack of reliable warning systems as well as poorly organised preventive and remediation measures. The forecasting of such events is becoming more uncertain as the effects of climate change appear more evident, and preparations previously considered more than adequate are proving insufficient.[41] Recent storms and consequent inundations, Hurricane Katrina being a pertinent example, have shown that governments have much to do in order to improve their contingency planning for such extreme phenomena. Yet public ignorance and political pressures

that allow urban developments in areas of high risk over-ride experience even after recent well-publicised events. More efforts should be made to learn from historical practices and experiences, for instance by exploring the present-day applicability of the stormwater management utilised by ancient civilisations,[42] or by restoring traditional floodplains as is currently done in Honduras.[43] A recently developed scientific methodology for obtaining new insights through such studies is hydroarchaeology, a multidisciplinary approach combining hydrology, laborative archaeology and history of water development.[44]

At the opposite end of the climatic continuum, droughts are becoming more frequent and severe also in regions where they have not previously posed a problem, such as the United Kingdom. Casting a historical glance on droughts can offer valuable lessons for contemporary debates concerning sustainable consumption of water resources. Set in the context of the United Kingdom, a discussion session revolved around four central questions: How do the constitution of drought and responsibilities for its mitigation change with the evolving institutional frameworks of water management? How do the spatial dimensions of drought shift with the growth and emergences of new logics of infrastructure management? How do changing institutional frameworks and infrastructure developments relate to competing formations of water consumers?

The presentations were followed by a discussion on what was termed the 'co-constitution of droughts', looking at consumer–provider interdependencies, in particular the responsibilities of both parties in the causation of droughts. The discussion dealt with the nuances of characterising the mediation between water supply and demand, and how public acceptance of engineering solutions changes over time. The concept of 'co-management' was then proposed in order to highlight the role of consumers historically, emphasising that they have always been part of the system although their roles have changed over time. It was concluded that, firstly, droughts are an evolving historical concept which have always existed but varied in their size, shape, duration and resolution as a result of socio-technical politics, institutional systems and norms, as well as climatic factors. Secondly, consumers as the co-constitutors of droughts have a key role in shaping how water supply systems function. Thirdly, drought and water scarcity are not the domain of private sector management only, so instead of focusing on ownership issues, more attention should be given to the underlying norms and routines of people's daily practices and their expectations of constant service.[45]

3. CONCLUDING REMARKS

The IWHA charter emphasises the examination and analysis of the evolution of specific water resources activities. Collectively these efforts reveal the history of water resources management – stewardship and services – and the associated

institutional, policy, technical, financial, environmental and social issues. There were many excellent papers offered at the Conference that adhered to this IWHA goal. However, a number of investigations described in the reported sessions would have benefited from a broader literature search and in-depth investigation of past and present successes and failures that bear on the topic of the presentations. That would likely have changed the findings of several papers.

A few comments pertinent to the theme of water and economy are offered below for further consideration. The purpose of the remarks is not so much to summarise the information presented in the conference papers as to provide a critical appraisal of the 'big picture', that is, to highlight some of the fallacies in current thinking, policies and popular viewpoints.

(i) Comprehensive historical research without pre-conceived views should be the starting point of every investigation, consideration of new undertakings, formulation of new policies and proposals for management arrangements at every level of government. The developing countries cannot afford to experiment with suggestions that are not founded upon real world successes. They have very limited time and funds available to meet their pressing needs – water is but one. For them it is essential to examine in depth proven approaches, evaluate choices and base their actions on what offers a solution with the highest potential for success now and provides flexibility for the future.

(ii) The human and economic consequences of ignoring history and pursuing the ever-expanding number of speculative concepts put forth today can be disastrous, as is evident in the increasing number of people without safe water supplies and safe wastewater disposal. For instance, privatisation of water supply/distribution systems was at one point believed to provide a solution to developing countries' service delivery problems but has proven to have limited application – reversals are currently more frequent.

To grasp the severity of the issue, one only needs to consider how far we are today (2008) from meeting the UN 2015 and 2025 Millennium Goals that were set in 2000. Among the primary deterrents has been the view of many within the community that new forms of governance should be devised before investments in facilities are financed. It is difficult to understand how these diversions can continue after forty years of deliberations, 'Water Weeks' within the water community and annual conferences attended by many thousands: much pontification with little reference to the history of existing successful water management, stewardship and services. The questioning of the obsession with the term IWRM in one of the Conference sessions was fully valid, though many would consider such questioning almost a sin. Both developed and developing countries offer proven examples of effective institutions that would allow the attainment of the Millennium Goals – on time. One can look at other historical information that bears on other decisions today pertaining to the advancement of the Goals.

In addition to successful institutions, there also seems to be a renewed interest towards revitalising historical constructions and methods such as qanats, rainwater harvesting and waterwheels. These offer valuable, proven-to-work options for future water management as long as certain limitations are born in mind. Qanats for instance are very geology-specific, while rainwater harvesting requires a reliable rainfall, and both methods might make only a small contribution to the vast water needs of mushrooming urban populations.

(iii) Water allocation and resources management should fully reflect both 'average' availability of water and, perhaps most importantly, the reliability of supply under all conditions. In the case of drought planning, what are the best long term water and land-use management policies and plans to meet the nation's needs related to its exploding urban centres, its growing food production needs and a healthy economy during its next three to seven years of drought? What policies and actions will be undertaken to meet the adopted environmental objectives under drought conditions? How much confidence can be placed on rainwater harvesting – or collection of dew or improved irrigation? Again, the history of successful policies and programmes should be studied in depth.

(iv) The world's leaders and public are grossly misled about water availability in most countries – most often about the potential recovery from irrigation 'inefficiencies'. Contrary to commonly expressed views, present and historical records show that irrigation is already very 'efficient' from the standpoint of water consumption within a river basin. For example, eighty-seven percent of the water diverted for irrigation within the US in the 1980s was consumptively used for plant growth.[46] This phenomenon is evident if one recognises that the excess return flows from one irrigated area either recharge underlying aquifers or, more typically, are reused multiple times by downstream irrigated areas or other users in the river systems until there is little or no flow discharge to the sea. A great many of the major rivers of Asia already run dry before reaching the ocean during the dry season. Basin consumption is one hundred per cent. The same holds true for inland cities along a common river – effluent discharge from one urban centre becomes a downstream supply to others. Thus, we should not delude ourselves with the popular assumption that we can 'save' large quantities of water through improved irrigation 'efficiencies': there is little water left to recover by new technologies or management actions – even less during droughts. Indeed, we have far less water in many countries than our political and policy leaders believe. The greatest 'inefficiencies' are found in the coastal urban zones where return flows are not treated and recycled, but wasted into the sea.

(v) A broad discussion was offered regarding dams and hydropower and the questions that often arise when considering additional facilities. Providing a reliable water supply for municipal and broader economic uses is an ever more serious concern of the developing countries as we encounter climate change. The rapidly expanding major cities in China, India and Indonesia are but a few

of those already in desperate straits with their regional aquifers severely overdrafted. The criticism of dams/reservoirs is blamed largely on hydro-generation and irrigation and most prominently directed towards the developing countries. However, many well-meaning critics fail to realise or mention that many developed countries are dependent upon dams. In the USA large cities such as New York, Washington D.C., Atlanta, Denver, San Francisco, Los Angeles, San Diego and Seattle all depend on reservoirs for their supply, and the economies of the western states would not even exist without such sources. Costly recycling of urban wastes and high energy consuming desalination are only now being actively discussed in the USA – but even with the plumbing in place, these sources will not be widely used for several decades. The long-term and short-term storage of floodwaters must be weighed by the developing world on the basis of historic economic development elsewhere in the world. And both reservoir and river diversions will require a parallel programme of enforcement of pollution control laws and high priority construction of wastewater collection and treatment facilities.

(vi) We talk much about water supply availability as if we knew the extent of the resources in every country. We discuss at length water-related problems, policies, institutions and programmes. However, essentially every developing country lacks adequate water quantity and quality data, stream and groundwater hydrologic data and present commitments to water users. Much of the generalised data from international agencies are seriously misleading. Wise water planning, allocation and management for current and future uses cannot be devised based on available information. Again, there is a reason for why we find more effective water resources management where there is a long history of comprehensive water data collection and analysis by government, with the data made available and free to all. The lack of such data is the most important shortcoming in formulating and funding a country's water resources management. Much is written about IWRM, yet essentially nothing about the ignorance of the public, industry and government agencies about the absolute need for such information to actually manage a country's land and water resources. Comprehensive hydrologic data collection, analysis and dissemination of information yields by far the greatest return on investment in water resources development and management. The fact that acquisition of comprehensive data/information is essential to effective resources management is proven by every successful country – and the methodology is readily available. New remote monitoring equipment allows more low cost and timely warnings of potential flood flows and harmful chemical spills from industry and accidents by any of the various modes of transportation.

(vii) Water resources planning and management at the basin level is being promoted heavily as a replacement of national/provincial level planning and management. But there are both constitutional and practical reasons why this

concept is not widely practised in developed countries that are effectively utilising their resources. The constitutional provision that a country's citizens own the nation's water resources, as is most common, is at the heart of management and the associated stewardship functions and related institutions. Citizens own the jurisdiction's water under the constitution. Government, as the citizens' steward, is mandated to manage all resources within its boundaries in a manner to best benefit all of its citizens in terms of their social, economic, environmental and security goals. Unitary forms of government, such as Bangladesh, Iran and Peru, retain this responsibility at the central level of government. In most federal forms of government, such as Germany, Canada, India, United States and China, the responsibility is held at the state/provincial levels. The State of Maharashtra, India, for instance sets forth its mandate as follows: 'The water resources of the State shall be used, conserved and managed to provide the maximum economic and social benefits for the people of the State and in a manner that minimises regional imbalance and maintains important ecological values within rivers and adjoining lands'.[47]

With regard to the practical reasons why basin management has remained fairly uncommon, Australia recently reversed the creation of its independent Murray-Darling basin authority so that the more pressing national human needs can be met. California, which alone has the world's eighth largest economy, could not have been created if its many basins were managed locally. These examples illustrate that successful jurisdictions manage their resources at whatever level – or combination of levels – best meet the desires of their citizens.

NOTES

The authors are grateful for the session summaries provided by the following session rapporteurs (in alphabetical order): Ms Jenny Appelblad, Dr José Esteban Castro, Prof. Ingrid Hehmeyer, Dr Vladimir Kuznyetsov, Dr Maurits Ertsen, Prof. Martin V. Melosi, Mr Harri Mäki, Mr Viktor Pál, Ms Riikka Rajala and Ms Annina Takala. The authors would also like to thank the two anonymous reviewers for their helpful comments and suggestions for improving the paper.

[1] California Water Plan, Bulletin 160-98, Vol. 1, p. 4-3.

[2] I. Hautamäki, P. Juuti, T. Katko, R. Rajala and E. Vinnari (eds.), *Book of Abstracts*, 5th IWHA Conference, Tampere, Finland, 13–17 June 2007. Also available online as an appendix to this issue.

[3] World Bank, *World Development Report 2008: Agriculture for Development* (Washington, DC: The World Bank, 2008).

[4] D.L. Vermillion and J.A. Sagardoy, 'Transfer of irrigation management services guidelines', FAO Irrigation and Drainage paper 58.

[5] T. Kärkkäinen, 'Irrigation management transfer – old ways for future water management'. IWHA2007 Conference CD.

[6] W.D.L. Stanley, 'Influence of water, food and economy on the livelihood of people in the world'. IWHA2007 Conference CD.

[7] Global Water Partnership, *Integrated Water Resources Management Tool Box* (Stockholm, 2001).

[8] F. Mukhtarov, 'The history and current status of integrated water resources management from a policy transfer perspective'. IWHA2007 Conference CD.

[9] O. Oktem, 'The history of integrated water resources management: analysing the inconsistencies'. IWHA2007 Conference CD.

[10] J. Hoogervorst, 'Future of integrated water resources management in Beninese municipalities'. IWHA2007 Conference CD.

[11] S.D. Limaye, 'Watershed management: a link between history and future of Indian hydrology'. IWHA2007 Conference CD.

[12] R. Faletti, 'Water problems for a world center in an arid region: California, a case study'. IWHA2007 Conference CD.

[13] M. Balali, J. Keulartz and M. Korthals, 'Water management paradigms in Iran: technical, social and ethical aspects'. IWHA2007 Conference CD.

[14] I. Madaleno, 'Water history in Easter Island and extreme Northern Chile'. IWHA2007 Conference CD.

[15] N. Wagle, 'Harvesting the rain: indigenous practice to means of socio-economic upliftment of rural poor'. IWHA2007 Book of Abstracts.

[16] W. Ankersmit, 'Dry feet clean water: 800 years of regional water management by Water Boards in the Netherlands'. IWHA2007 Conference CD.

[17] N. Dixon, 'Past and future collaborative management of New Zealand's North Island waters'. IWHA2007 Book of Abstracts.

[18] P. Schmitthenner, 'The legacy of Arthur T. Cotton's plans to link India's rivers'. IWHA2007 Conference CD.

[19] D. Blanchon, 'The constitution of techno-nature: a few remarks from the South African experience'. IWHA2007 Book of Abstracts.

[20] S. Niemi, 'Adolf Erik Nordenskiöld – explorer of the Arctic waters'. IWHA2007 Conference CD.

[21] J. Haarhoff, 'Intellectual property disputes during the early development of sea-water distillation'. IWHA2007 Conference CD.

[22] World Commission on Dams, *Dams and Development. A New Framework for Decision Making* (2000).

[23] International Energy Agency, *Key World Energy Statistics* (2007).

[24] K. Showers, 'Ancestor of the Southern African power pool: Congo River's Grand Inga hydro-electric Scheme'. IWHA2007 Conference CD.

[25] T. Myllyntaus, 'Conciliating hydropower conflicts in industrial Finland'. IWHA2007 Conference CD.

[26] E. Björsvik and P.E. Faugli, 'Sustainable water management in Norway for a hundred years: the industrial area Odda – Tyssedal as a case study'. IWHA2007 Conference CD.

[27] S.-C. Georgescu, A.-M. Georgescu, R.M. Damian and J.-L. Achard, 'Past and future of water turbines in Romania'. IWHA2007 Conference CD.

[28] E. Tempelhoff and J. Tempelhoff, 'A story of two dams: government, industry and civil society in north-eastern South Africa 1994–2007'. IWHA2007 Conference CD.

[29] M. Kummu and O. Varis, 'Human impacts on hydrology in Mekong – past, present and future'.

[30] M. Smith, 'Dam removal: a taxonomy with implications for economic analysis'. IWHA2007 Conference CD.

[31] M. Reinsborough, 'The Silent Valley reservoir 1923–1932'. IWHA2007 Conference CD.

[32] M. Lewis, 'Rivers, peripheries, and politics in the making of Japan's modern history: the case of Toyama'. IWHA2007 Conference CD.

[33] U. Bhattacharya, 'Management of water channels: some reflections on colonial projects and their objectives'. IWHA2007 Conference CD.

[34] V. Pál, 'Damming the Danube, symbolizing the dam. The environmental history of the Gabčikovo-Nagymaros dam project'. IWHA2007 Book of Abstracts.

[35] A.A. Bosch, 'A forgotten river? The struggle for the improvement of the Meuse in the Dutch province of Limburg 1830–1918'. IWHA2007 Conference CD.

[36] C. Disco, 'The nation-state and the rivers, spaces and times on Dutch rivers, 1795–1825'. IWHA2007 Book of Abstracts.

[37] B. Toussaint, 'The changing role of Rijkswaterstaat as knowledge institute in the Dutch delta between 1800–1950'. IWHA2007 Book of Abstracts.

[38] E. Mostert, 'The many sources of the management of the Rhine'. IWHA2007 Book of Abstracts.

[39] T. Ruf, 'How to interpret the old maps on irrigation schemes in Egypt and in Morocco'. IWHA2007 Book of Abstracts.

[40] M. Kleiche Dray, 'The Office Régional de Mise en Valeur du Haouz Archives: Testimonies of modern irrigation introduction in the twentieth century Morocco'. IWHA Book of Abstracts.

[41] L. Koncsos, E. Balogha and G. Fonyó, 'Hungarian flood control: past and future'. IWHA2007 Book of Abstracts.

[42] P. Hlavinek, 'New/old ways for storm water - learning from the history'. IWHA2007 Conference CD.

[43] K. Ahti, 'Devastation of City Ocotepeque, Honduras, in 1934'. IWHA2007 Book of Abstracts.

[44] E. Lövgren, and S. Sandelin, 'Hydro archaeology as a methodology for a better understanding of culture development in a water history perspective'. IWHA2007 Book of Abstracts.

[45] H. Chappells, W. Medd, V. Taylor and F. Trentmann, 'Drought is normal: the socio-technical evolution of drought and water demand in the UK, 1893–2006'. IWHA2007 Conference CD.

[46] W.B. Solley, C.F. Merk and R.R. Pierce, *Estimated Use of Water in the United States in 1985* (US Geological Survey, 1988).

[47] State of Maharashtra, *Maharashtra State Water Policy* (Mumbai, India: Water Resources Department, Government of Maharashtra, 2003).