

hydrolink

SPECIAL ISSUE

SEA LEVEL RISE ADAPTION MEASURES

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A CHANGING PLANET AND HYDROINFORMATICS AS A DECISION SUPPORT SYSTEM

EDITORIAL BY PROF. MICHELE MOSSA

The word informatics has many meanings, such as computing, computer science, informatics engineering, and so on. In its meaning of information technology it is the study, development, implementation and management of computer-based information systems. In this case it could be education informatics, business informatics, computational informatics, geoinformatics, medical informatics and so on. In particular, hydroinformatics is the inter-disciplinary field which links water and environmental problems with various computational modeling methods and fast developing information and communication technologies.

The Institute for Water Education of UNESCO-IHE has also been dealing with various burning, current issues related with hydroinformatics. So why is hydroinformatics so important? New computer based modeling tools, Web-based information and knowledge systems, GIS are increasingly used to provide support for decision making for flood and river management, urban drainage and supply networks, estuaries and coastal waters, at all levels of management and operations.

The present issue of Hydrolink is focussed on Sea Level Rise and repercussions on coastal protection and and its costs but it is also devoted to hydroinformatics. When sea levels rise rapidly, as they have been doing, even a small increase can have devastating effects on coastal habitats. As seawater reaches farther inland, it can cause destructive erosion, flooding of wetlands, contamination of aquifers and agricultural soils, and lost habitat for fish, birds, and plants. In addition, hundreds of millions of people live in areas that will become increasingly vulnerable to flooding. Higher sea levels would force them to abandon their homes and relocate. Two articles on the Japan tsunami relate to the impact of extreme events and



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sea level rise on the safety of existing coastal protection measures, with the article on Bangladesh emphasizing the complex interaction of sea level rise on human development and the financial cost of increased protection. At the same time in the last few weeks we have seen a series of devastating floods around the world most recently in Sichuan. What is interesting is the extraordinary contrast between the Asian floods with thousands still missing in Uttarakhand, India and a hundred thousand evacuated, but limited discussion on financial damage, and the recent disastrous floods in Germany and Hungary, where the economic cost has been reported by Munich Re as possibly exceeding 12 Billion Euro (but yet with only 16 lives lost, fortunately).

Hydraulic engineering mainly deals with the Earth system. But it is necessary to expand our view to look both at processes affecting the whole Earth (such as sea level rise and floods) and how those processes influence our lives. The latest developments in hydroinformatics link science and engineering practice together with stakeholders' views as well as social considerations (such as the costs which must be sustained in order to protect the coasts against rising sea levels). Finally both inland flooding and adaptation to sea level rise involve similar issues: how to balance protecting human life and goods against what society regards as an affordable financial cost. Here our IAHR community can help in both developing better hydroinformatic tools to help society evaluate different development scenarios and at the same time we can assist in providing tools to help in disaster handling. This is the essence of the important letter which we publish written by our German university colleagues, considering that our community can bring our scientific knowledge to assist in the social dialogue. I hope you enjoy this issue.



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ISSN 1388-3445

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NUMBER 2/2013

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LOCAL FEATURES OF TSUNAMI THE 2011 TOHOKU EARTHQUAKE

BY TOSHINORI OGASAWARA

Iwate Prefecture is situated in the northern area of the main island of Japan. Offshore, there is a boundary between the Pacific Ocean tectonic plate and the North American plate. This plate boundary is also known as a subduction zone and generates large earthquakes. As a result, the coastal areas of Iwate have suffered damage from numerous tsunamis.

Furthermore, when tsunamis occur offshore of Chile, the tsunami waves pass Hawaii and reach the shores of Iwate, where the energy of the waves is concentrated by refracting on the continental shelf. The coastal geomorphology is that of ria coasts, which are steep and narrow bays. Tsunami waves breaking in such a bay become higher in the inner bay. Three major tsunamis have hit the coast in the last 125 years: the 1896 Meiji Sanriku tsunami, the 1933 Showa Sanriku tsunami, and the 1960 Chile tsunami. Thus, tsunami disaster countermeasures, such as breakwaters, seawalls, and vertical evacuation buildings, were being constructed (about 73% complete as of 2010). Nevertheless, because the 2011 Tohoku Earthquake tsunami was larger than expected, the tsunami destroyed or overcame the seawalls that were present and inundated many communities (Figure 1). The 2011 Tohoku tsunami was responsible for an enormous loss of human life and property. Places of refuge were temporarily overwhelmed with over 54,000

tsunami victims. As of 31 March 2013, official fatalities were 4,672 with an additional 1,147 missing in Iwate Prefecture. The number of destroyed and partially damaged houses was 23,072. In Iwate Prefecture, which was seriously damaged by the 2011 Tohoku tsunami, it was impossible to protect the settled areas using tsunami countermeasures alone. Therefore, if a large earthquake and tsunami such as the 2011 event occurs again, evacuation to higher elevations must begin as soon as possible.

Figure 2 shows estimated inundation heights and run-up heights with latitude based on historic tsunami records from the 1896 Meiji Sanriku tsunami, the 1933 Showa Sanriku

tsunami, and the 1960 Chile tsunami. Measurements for the 2011 Tohoku tsunami were obtained from the 2011 Tohoku Earthquake Tsunami Joint Survey Group. Heights shown in Figure 2 are measured from sea level, generally excluding astronomical tides and inundation, and were determined from watermarks on buildings and trees. The 2011 Tohoku tsunami was much larger than the Chile tsunami. Compared to the Meiji Sanriku tsunami, the maximum run-up heights for the 2011 event were greater in many areas and similar in some regions. For the Showa Sanriku tsunami, run-up heights were limited to about 20 m in most areas (green shading in Figure 2) and the maximum value was about 30 m. In the

“because the 2011 Tohoku Earthquake tsunami was larger than expected, the tsunami destroyed or overcame the seawalls that were present and inundated many communities”



Figure 1. Destroyed tsunami seawall in the Taro district of Miyako City

MI DAMAGE FROM AKE IN IWATE PREFECTURE

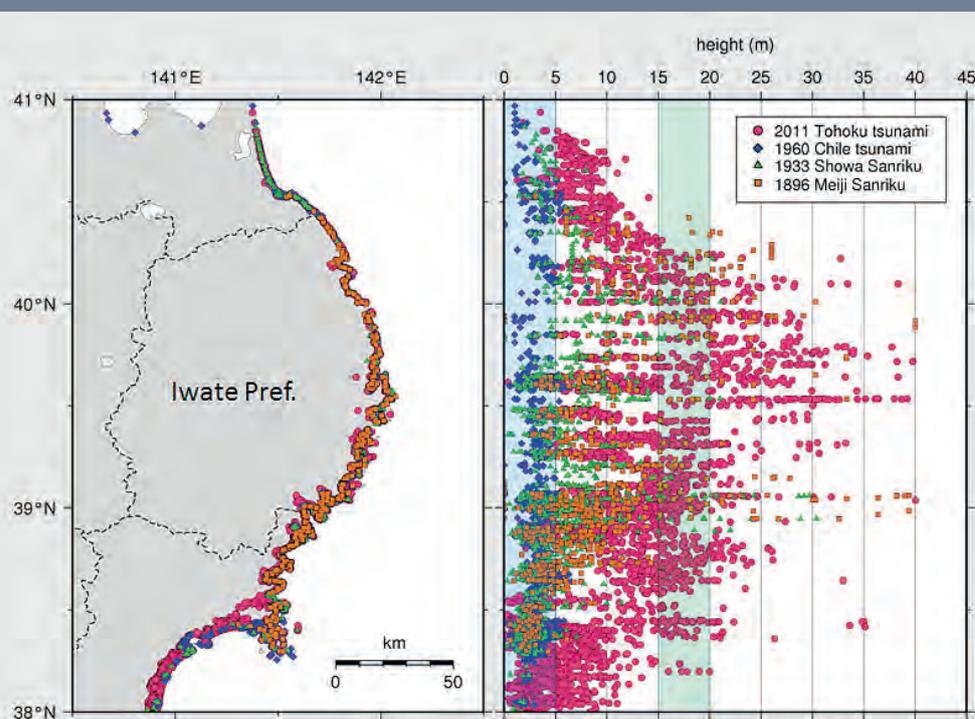


Figure 2. Measured tsunami heights versus latitude, including tsunami records
 ● Tohoku tsunami (inundation and run-up heights), ◆ Chile tsunami, ▲ Showa Sanriku tsunami, ■ Meiji Sanriku tsunami).

Chile tsunami, run-up heights were about 5 m (blue shading in Figure 2). Areas in which the run-up heights for the Meiji Sanriku tsunami exceeded 15 m were restricted to the Sanriku coast. On the other hand, run-up heights exceeded 15 m during the Tohoku tsunami over a wide area from Miyagi to Iwate Prefecture. Characteristically, the largest waves struck the flat coastal plain between Sendai City in Miyagi Prefecture and Soma City in Fukushima Prefecture. In the ria coastal region in Iwate Prefecture, as the 2011 Tohoku tsunami had similar run-up heights to the Meiji Sanriku tsunami, two major tsunamis of this size are considered to have occurred within 125 years. On the other hand, along the flatlands of the Sendai Plain, it was the largest tsunami generated since the Jogan earthquake and tsunami in 859.

In the 2011 Tohoku tsunami, the maximum run-up height was 40.0 m at ria coasts in Sanriku.

Many houses were flooded and fishing harbors were seriously damaged over a wide area of Iwate Prefecture. Fishing ports such as Miyako City were damaged and ships were grounded. Measures need to be taken quickly to address collapsed breakwaters and seawalls as well as eroded coastlines. The tsunami also traveled up the rivers in the area, such as the Otsuchi River in Otsuchi Town, the Mori River in Ofunato City, and the Kesen River in Rikuzentakata City, overflowing the riverbanks in several places.

There are small fisheries harbors in each bay throughout the Sanriku coast. It is particularly important to determine how to defend these fishing villages from a large tsunami. Aneyoshi district in Miyako City is introduced as an example as follows. Aneyoshi district was severely damaged by both the Meiji and Showa Sanriku tsunamis. This district is located along the deepest area of Aneyoshi bay and is characterized by topography that concentrates



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tsunami energy. In the Tohoku tsunami, the run-up height was recorded as about 40 m and a fishing port and camping site were destroyed. Fortunately, because the community had previously moved to the highlands, which are about 70 m above sea level, the houses suffered little damage. The Tohoku tsunami inundated areas about halfway up the road to the community from the fishing port and hewed down trees and shrubs along the road, creating a desolate scene. A stone monument warning of the tsunami is famous in Aneyoshi district, engraved with "Do not build houses below this hill." This stone monument, erected after the 1933 Showa Sanriku tsunami, had become forgotten and overgrown by forest. However, when work was carried out to move the road, the stone monument was uncovered and reset at the edge of the current road. Therefore, we must address the issue of how best to transmit our experiences with natural disasters to posterity.

ASSESSMENT OF TSUNAMI PROPAGATION FROM VIDEO RECORDINGS

BY HITOSHI TANAKA



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One of the problems in studying tsunami waves is how to acquire field data under intense hydrodynamic conditions. Various measurement devices are available for that purpose.

Nevertheless, especially in a case of a mega tsunami, these devices may suffer damage from the tsunami and cease to function properly. Past tsunami events, such as The Indian Ocean Tsunami of 2004 or The Great North East Japan Tsunami of 2011 have shown that measured data availability was limited during a mega tsunami. The tsunami damaged a large number of water gauges installed at the tidal observatory in coastal areas and rivers. In addition, the tsunami force may have caused error readings. Thus, detailed information, such as fluctuation of the water level, was lost. Post tsunami surveys, i.e. tracing, water mark, were often conducted, which may provide some degree of understanding on tsunami propagation process, yet it is not the live actual condition.

Nowadays, with advances in technology, it is easy to record video of various moments, including a tsunami event. In the case of The North East Japan Tsunami of 2011, there were



Figure 1 Video recordings locations. Video data, covering Sendai Plain, were collected from various sources.

video recordings from various sources. Video recordings during the tsunami are available from survivors, CCTV, TV stations, and other related agencies. These videos can be obtained from corresponding agencies and some of them are available even in You Tube. Although they may not reveal the water level data, they may contain other information. These videos provide live data of the tsunami event that may be helpful for explaining the tsunami propagation process.

The Great North East Japan Tsunami of 2011

The Great North East Japan Tsunami of 2011

was one of the biggest natural disasters in history. The tsunami event prompted researchers and governmental organizations throughout Japan to enhance existing measures for prevention of tsunami disaster. The tsunami was generated by a 9.0 (MW) mega earthquake off the coast of Japan. The earthquake occurred at 14:46 (Japan Standard Time) on 11 March 2011. It caused 5-8 m upthrust on a 180 km wide seabed. The tsunami run-up height in some places reached to about 40 m. The wave brought destruction on the north east coast of Japan. In some places, the tsunami wave wiped out an entire town with thousands of casualties.

Video Data

The Sendai Plain field in Miyagi Prefecture is one of the most affected areas due to the event of The Great North East Japan Tsunami of 2011. The tsunami wave damaged infrastructures along the shoreline including Sendai International Airport, the Sendai Port and residential areas. Due to its importance, the area received considerable publicity during the tsunami.

The tsunami arrival was recorded on video at some places. There were videos taken from helicopters that were owned by various organizations. In addition, survivors at some places recorded some videos showing the tsunami propagation process on land and in rivers. These videos were analyzed further to obtain the tsunami arrival time, tsunami-induced velocity and wave celerity. The video images were collected in different parts of the plain with different topological features, including the river (R), floodplain (F), and the land (L) as shown in Figure 1. There were videos showing tsunami intrusion into the Natori River (R1), the Nanakita River (R2) and the Sunaoshi River (R3). The video recordings at R1 included the floodplain area (F) in the river. L1 and L2 are respectively located around the right and left bank of the Natori River, L3 is located around Onuma Lake, and L4 is located around Sendai Airport. The effect of elevated road on tsunami propagation on land can be observed in the video data from L1. In addition, videos of tsunami propagation over land were available for different land cover condition. The area around Sendai Airport (L4) was mostly open area without any buildings.

Tsunami Celerity

The tsunami celerity was obtained by analyzing the tsunami tip locations over time from the video images. Frames were captured from the video to obtain the location of the tsunami tip. The camera movement or camera viewpoint may reduce the accuracy of the analysis. Therefore, the location of the wave tip at each frame was determined based on fixed points in the frame. Structures, buildings, roads, or other marks with no dislocation are suitable fixed points. The location of the tsunami tip at a frame was compared to its location in subsequent frame. The dislocation distance and the time difference represent the wave celerity according to the following equation.

$$C = \frac{\Delta x_t}{\Delta t}$$

where C is the wave celerity, Δx_t is the distance between tsunami tip at two consecutive frames, and Δt is time interval between the frames.

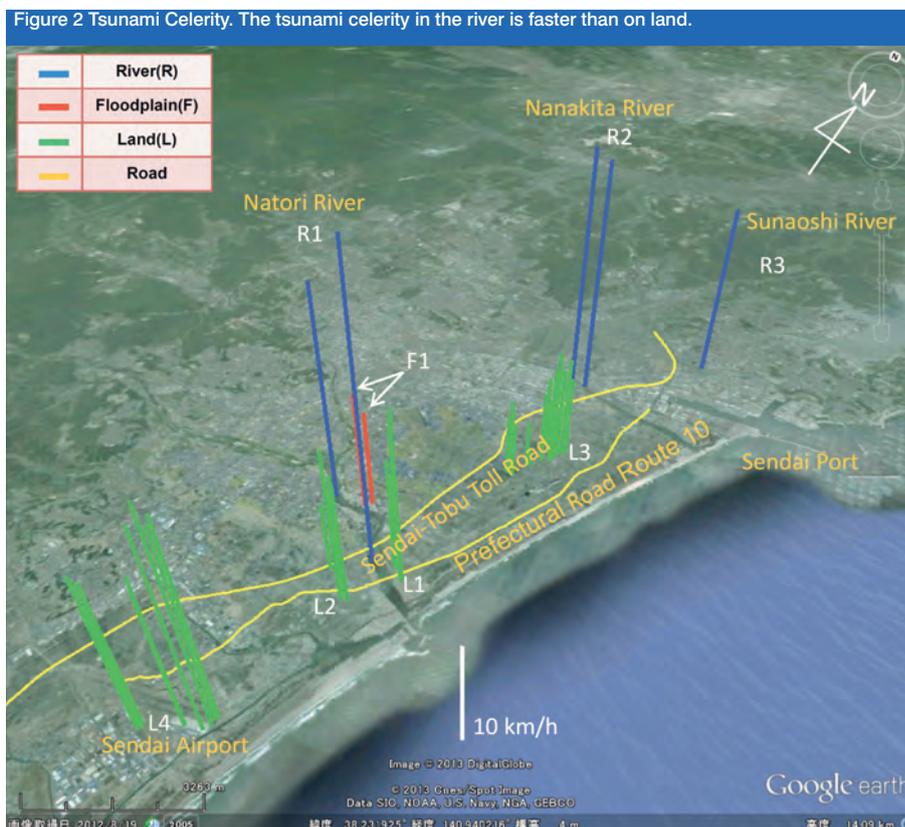
Figure 2 shows the celerity magnitude at different locations based on the video analysis. It clearly shows the celerity differences in each location with different topology and land cover. The video recordings at R2 were obtained from two different sources. Nevertheless, the analysis results between these videos show no significant differences in the celerity magnitude. The average celerity value at R2 is 24.5 km/h with non-biased standard deviation of 0.9 km/h. The videos at L2 and L4 were also collected from more than one source. However, they are located on land and not representing the same point. Hence, there is no similarity in the result which may arise due to different land cover, topology or other factors.

The result reveals that the tsunami in a river and on the land behaves differently. The tsunami celerity on the land was significantly lower than the celerity in a river. In addition, the celerity magnitude in the river gradually decreases with lower rate than the celerity magnitude on the land. The celerity in the downstream and upstream of the Natori River (R1) shows no significant reduction in the magnitude although propagation distance was approximately 3 km. Overall, celerity in rivers behaves similarly, with minor differences. The river discharge, river scale, normal water depth and river meandering are some of the factors that may cause these minor differences.

The video recordings at the Natori River (upstream R1) reveal interesting information on the tsunami propagation in the river. The celerity at R1 is higher than the celerity on its floodplain (F1). At F1, the river embankment is straight instead of following the curve of the main river (Figure 1). Due to the river meandering, the tsunami intrusion flowed along the curved main channel as well as on the floodplain. Due to the difference of roughness, higher magnitude of celerity was found at upstream R1 (21.6 km/h) than the celerity at F1 (10.7 km/h), although R1 is further upstream from the river mouth (4.5 km) than F1 (3.7 km).

The tsunami propagation over the land is affected by the land cover condition. In addition, flow resistance from debris may have significant influence on tsunami propagation on the land. L4, located around Sendai Airport was mostly open area and covered with asphalt. Therefore, this location had smooth surface as compared to the other locations, resulting in higher celerity as compared with other land locations.

The tsunami celerity was significantly reduced after flowing over Road Route 10 at L1. The celerity magnitude of the tsunami before it reached the road was 15.6 km/h. This value was greatly reduced to 9.3 km/h after passing the road.



UNDERSTANDING CLIMATE CH LIVESLIHOODS IN COASTAL BAN

BY ROBERT J. NICHOLLS, CRAIG HUTTON, ATTILA N. LÁZÁR, MD. MUNSUR RAHMAN, MASHFIQUIS

In recent years, there has been a growing concern about the effect of climate-induced sea-level rise on the environment, population and livelihoods around the worlds' coastline. However, these issues are highly spatially variable, as sea level is only one of several drivers of coastal change (Nicholls et al 2007). It was recognised in the 1980s (Milliman et al 1989) that deltaic environments are amongst the most vulnerable coastal areas to such rise because of their low altitude and often large, poor and growing population.

Threats act on multiple scales including global (e.g. sea level rise), regional (e.g. catchment management reducing water and sediment input) and delta plain (e.g. water extraction, sediment starvation, natural and more importantly human-induced subsidence) scales. The result of these changes might result in an increase in flooding, salinization of water resources and soil, land loss due to erosion, subsidence and inundation, and degrading the quality of ecosystem services such as crop productivity, fish stocks and protection against storm surges. Thus, delta environments are complex social-environmental systems where the change is only partially driven by sea level rise and climate change, and human-induced development activities are also critical drivers.

Drivers of coastal change in South-West Bangladesh

The Ganges-Brahmaputra-Meghna (GBM) Delta

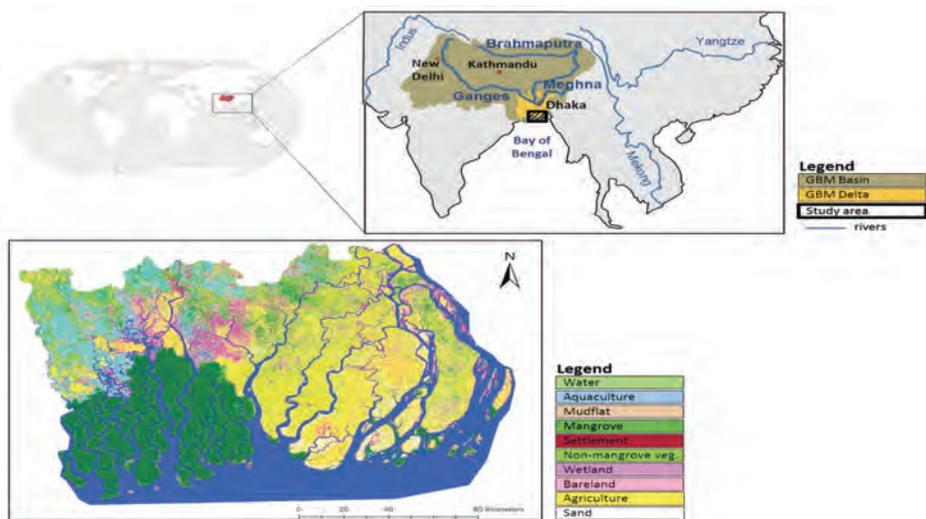


Figure 1: Location and land cover of the study area within the overall Ganges-Brahmaputra-Meghna Delta and wider region.

is one of the world's most dynamic and significant deltas (Figure 1). The total population is in excess of 100 million people in both Bangladesh and India (West Bengal). The source of the Ganges and Brahmaputra rivers is in the Himalayas and freshwater travels through five countries (China, Nepal, India, Bhutan, Bangladesh) before reaching the GBM delta and the Bay of Bengal. The delta is changing rapidly with a growing urban population including major cities such as Dhaka, Chittagong and Khulna. At the same time, the delta has important ecosystem services which have allowed this large population to be fed and to steadily grow the economy (e.g. intensive rice paddy), as well as being home to the world's

largest mangrove forest, the Sunderbans. The study area in Figure 1 is extremely low and flat: the elevation ranges from 1 m on tidal flats, to 1-3 m on the main river and estuarine floodplains. Hence, it is the most vulnerable area in Bangladesh and there is significant poverty of the 14 million inhabitants (>50%, WRI 2005). There are multiple threats from human and climate-induced upstream, deltaic and marine changes, recently receiving international attention due to its high vulnerability to climate change (World Bank 2010) and a succession of major storms and cyclones such as Cyclone Sidr in 2007, Cyclone Aila in 2009 or Tropical Storm Mahasen in 2013. During storm tides and in times of low river flow, salinization is also of major concern.

Biophysical Considerations of the Delta

When considering the physical processes (Figure 2), sea level rise, erosion, river floods, cyclones, storm surges, saline intrusion, upstream damming and subsidence affects the morphology of the delta plain (Woodroffe et al. 2006). Relative (or local) sea level rise is estimated to be up to 8 mm/year (Singh 2002) implying significant subsidence (i.e. the gradual sinking of an area), which is alarming although

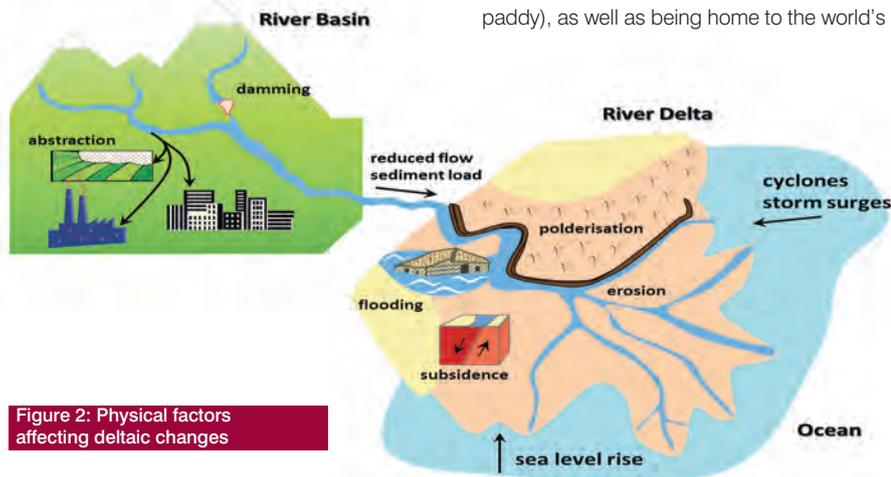


Figure 2: Physical factors affecting deltaic changes

ANGE AND GLADESH

SALEHIN, TUHIN GHOSH

this is disputed and needs better definition. Subsidence in Bangladesh is caused by tectonic movements, sediment compaction and anthropogenic changes (e.g. cropping/farming methods, deforestation, urbanisation, etc.). However, the other factors of coastal change might be equally important. Erosion is a consequence of river flows (i.e. bank erosion), waves, and overland flows during heavy rainfall and flooding. River floods mainly occur during the wet season, when a large volume of water is received from the upstream catchments. This results in 10-68% inundation of Bangladesh annually (FFWC, Salehin et al. 2007). Cyclones and storm surges also occur frequently, causing increased erosion, crop/livestock losses and inundation of land with saline water. This further increases the already serious salinity issue, which has a detrimental effect on the agriculture production. If land becomes saline, there is little option what the land can be used for in the future: producing limited saline tolerant crops or turning the field into a shrimp farm. The damming of upstream river reaches and water diversion to irrigation and other uses in India significantly reduce the amount of incoming freshwater and sediment during the dry season, which allows greater saltwater intrusion. This situation is further worsening by polderisation in coastal Bangladesh, where the land is surrounded by embankments to keep the saline tidal sea water and river flood water out of the agriculture fields. The long-term downside of polderisation is that river floods do not deposit nutrient rich sediments on the fields and siltation takes place in the rivers as a result of the decrease in tidal volume during flood tides. Hence, elevation is lost through rise in river bed elevation and subsidence (making drainage more difficult and increasing potential flood depths and waterlogging) and the soil quality gradually decreases unless expensive fertilisers are purchased.

Socio-Economic Context of the Delta

There is growing socio-environmental stress on the delta. Populations are undergoing complex shifts in behaviour with net migration out of the delta region to the main cities. This process is



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Craig Hutton's research, applied research & consultancy focus lies at the intersection between the environment and

social implications of environmental/ climate change and management for sustainable development. This socio-environmental research emphasizes the implications of climate change/environmental vulnerability of communities, land cover and earth observation in decision-making support systems Management (IWF) of Bangladesh University of Engineering and Technology (BUET).



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project. His research interest lies in the mathematical representation of complex systems such as sediment transport, aquatic ecological interactions and socio-ecological connections.



Munsur Rahman focuses his research on River and coastal processes and management, morpho-dynamics of

riverine and coastal ecosystem and related issues. He is interested in Ecosystem services of river, coasts and floodplain system through blending of Indigenous and scientific approach. Munsur is a Professor at Institute of Water and Flood Management (IWF) of Bangladesh University of Engineering and Technology (BUET).



Mashfiqus Salehin's research focuses on hydrologic modelling of water resources at regional and

national levels, hydrogeologic analysis of coastal aquifers and saltwater intrusion, and flood hazard, vulnerability and risk analysis. He has a major interest in socio-eco-technical approaches to water management and transboundary water issues. Mashfiqus is a Professor at Institute of Water and Flood Management (IWF) of Bangladesh University of Engineering and Technology (BUET).



Tuhin Ghosh is a faculty member in School of Oceanographic Studies, Jadavpur University, India. His research

interests are in the field of coastal ecology, geomorphology, disaster management and ICZM. His interest is in the socio-ecological research along with the climate change impacts and possible adaptation strategies.

complex and a number of factors are involved. Shrimp farming is becoming an attractive option where salinity has risen, but is becoming recognised as a temporary solution with inequitable distribution of benefits away from the poor and progressively landless. Extreme events can cause immediate catastrophic financial situations for families, and there is only a limited safety net for the poorest. However, the growths of flood warnings and cyclone shelters have greatly reduced the death toll during extreme floods and cyclones. Bio-physical processes play an important role in people's lives. Crop productivity, forest goods, fish stocks and arsenic pollution of groundwater resources are directly affecting the livelihoods of the population.

Governance Dimensions

Each component of the ecosystem (i.e. water, fisheries, vegetation, forests and wildlife, etc.) is governed by a different legal regime which will be identified. Laws and institutions rarely include cross-cutting issues and are often confined within sectorial boundaries. This is somewhat compounded by a fragmented legal regime and inconsistencies within laws and regulations. Weaknesses in government planning structures in combination with the heavy reliance on donor funding potentially result in donor initiated projects that are not optimum in achieving national goals and policies.

The ESPA Deltas Project

Environmental change and people's livelihood is complex in deltaic environments. There is a

lack of understanding of the relative importance of the above factors. The ESPA-funded "Assessing Health, Livelihoods, Ecosystem Services and Poverty Alleviation In Populous Deltas" project (2012-16, <http://www.espadelta.net/>) aims to address this gap in a policy relevant way. The project was founded on the recognition of the interaction of the biophysical, governmental and socio-environmental factors unfolding on the delta and has established an integrative research process based upon these three main themes. The project is providing policy makers with the knowledge and tools to evaluate the effects of policy decisions on people's livelihoods in the tidal influenced delta plain. It is being conducted by a multidisciplinary and multi-national team (24 institutes from UK, Bangladesh, India and China) of policy analysts, social and natural scientists and engineers using a participatory, holistic approach to formally evaluating ecosystem services and poverty in the context of the wide range of changes that are occurring. The approach is being developed in the coastal Bangladesh study area (Figure 1) but is designed to be generic and transferable to other deltaic settings. The methodology is built upon a combined system-based conceptualisation of the human-environmental interactions and stakeholder engagement. The four major building blocks of the project are: (1) policy analysis, (2) understanding of social interactions, (3) understanding of the status and changes of the biophysical environment, and (4) integrative modelling of the system using

scenarios.

The ESPA Deltas methodology is built on substantial stakeholder engagement and iterative learning throughout the project. There is participatory involvement of stakeholders (from government to civil societies) in all stages of the research starting from the identification of research questions to developing scenarios and exploring these within model frameworks. This ensures trust, interest and willingness to participate. This integrative tool will be used as an iterative learning instrument to explore a range of climate, social and governance scenarios in close collaboration with decision makers. The project will identify perceived critical threats and inform policy makers of the potential benefits of policy changes to promote sustainability, to reduce poverty and to embrace integrated management.

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River Flow 2014

International Conference on Fluvial Hydraulics
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HIGH RISE: COSTING

AS SEA LEVELS RISE WE WILL NEED TO INCREASE PROTECTION
 SALLY BROWN AND ROBERT J. NICHOLLS

Media reports indicate almost daily how potentially devastating the effects of climate change and associated sea-level rise could be. A simple Google News search for 'sea-level rise' illustrates the diversity of impacts, from migratory birds to energy supplies to soil salinisation to flooding. These impacts could have a significant impact on the environment and the people who reside there – typically the coastal zone is about three times more densely populated as further inland (Small and Nicholls, 2003). As engineers, we have the ability to protect those who are vulnerable, such as through building hard defences such as sea walls or dikes. But in order to do this – particularly over the long-term – we need to understand how much sea levels might rise and how much it might cost so that the financial commitment can be assessed into the future. This is especially true when poorer countries may seek financial assistance to support such adaptations. In 2010, the World Bank published its 'Economic of Coastal Zone Adaptation to Climate Change' report (Nicholls et al., 2010) to answer these questions, which was part of a larger 'Economics of Adaptation to Climate Change' project which looked at a number of sectors (World Bank, 2010).

Rising sea levels

Sea levels have been naturally varying for thousands of years, but it is only over the last century or so that man is believed to influence the rate of sea level change. From 1900 to 2009 sea levels rose 1.7 ± 0.2 mm/yr, partly due to a warming atmosphere (Church and White, 2011). Sea levels are expected to continue to rise, particularly as temperatures continue to increase due to human-induced global warming. However the magnitude of future sea-level rise is uncertain for a range of reasons including the unknown rate of ice melt from small glaciers and ice caps, and the large ice sheets of Greenland and Antarctica. Consequently, the World Bank study analysed a range of global mean sea-level rise scenarios (or plausible futures) of 16 cm to 38 cm by 2050 with respect to 1990 levels.

Modelling protection against sea-level rise

Rising sea levels have many consequences for

those residing or living in the coastal zone, including flooding and erosion of land. This will almost certainly trigger adaptation to reduce impacts. Traditionally one or more of three main approaches may be taken (Figure 1, also see Linham and Nicholls, 2010):

- To retreat, and move away from the coast;
- To remain in place, but accommodate for physical changes, by altering one's day-to-day actions, homes or economy in order to cope (e.g. raising buildings, changing crop type etc)
- To remain in place and continue on with 'business as normal' and protect valuable assets (e.g. building dikes, nourishing beaches etc).

In the study, the option of protecting against sea-level rise was investigated for 143 low income to upper middle income countries, where gross national income per capita is \$12,475 or less (hereafter known as World Bank countries). Protection and costs were calculated by the Dynamic Interactive Vulnerability Assessment (or more simply DIVA), an impacts model used to assess physical, social and economic change in coastal zones (Hinkel and Klein, 2009; Vafeidis et al. 2008). DIVA breaks down the world's coastal zone into over 12,000 segments (average length 85 km) and associates each segment with a range of geophysical, ecology, economic and demographic information. Together with climate change, a scenario of population change and economic growth were considered, where economic growth is regionally orientated and population growth is high over the 21st century, increasing from 6 billion in 2000 to over 9 billion by 2050.

The global mean sea level scenarios were downscaled to local segment level and were combined with land level change using estimates of glacial isostatic adjustment and delta compaction. Other factors such as human-induced subsidence were not considered due to lack of data. For each segment, the local rates of sea-level rise were added to the exceedance curves – which calculate the return period of an extreme sea flood event, such that as sea levels rise, it would be expected that an extreme water level

today would happen more often. It assumes that present storm surge characteristics are simply linearly displaced as relative sea levels rise. Cyclones may intensity with climate change, thus further rising extreme sea levels during storm conditions. Thus, an arbitrary 10 % increase in 100-year extreme water levels, combined with the highest sea-level rise was evaluated. From these high water levels, DIVA estimates the amount of land loss due to erosion and damage due to flooding.

Impacts also depend on the level of coastal protection. In the absence of a global dataset detailing protection levels, the baseline protection (for 1995) was estimated using a 'demand for safety' function. Given the socio-economic conditions, DIVA includes two types of protection; dikes (protecting from the open sea and the coastal part of river estuaries) and beach nourishment (to preserve protective beaches). As sea levels rise and/or as population and economies grow (represented by gross national product per capita), defences will increase. As hard defences need to be efficient, cost-effective and have a long design lifetimes, it was assumed that the defences were built anticipating climate and sea level conditions fifty years into the future i.e. in 2050 assuming the sea levels could potentially rise up to 1.26 m by 2100 (for the high scenario). Beach nourishment costs only considered the conditions in the timeframe measured as the beneficial effects of nourishment are felt immediately, so as in engineering practice, periodic top-ups are required. All financial results are given in 2005 US dollars, with no discounting.

	Time	
	2050	2100
Sea-level rise above 1990 levels (cm)		
Low	16	40
Medium	29	88
High	28	126

Table 1. Climate-induced sea-level rise scenarios used in the Nicholls et al. (2010) study

CLIMATE CHANGE

ADAPTATION LEVELS TOO AND THAT COMES AT A FINANCIAL COST.

Costs of protection

The costs of protection were projected in 2050 for a low, medium and high sea level rise (see Table 1), with the latter also computing a 10% increase in surge height due to the intensification of surge activity. Additionally, a hypothetical scenario of no sea-level rise (i.e. accounting for land movement only) was undertaken to evaluate residual effects. Results for the total adaptation (protection) costs from dike building and nourishing beaches are shown in Figure 2. The results indicate a wide range of costs based across the scenarios, and that the magnitude of sea-level rise is more important than timing. Hence we are already committed to many of these costs as some sea-level rise is inevitable.

It was observed that:

1) There are baseline costs even if climate-induced sea-level rise is zero.

Land subsidence, increasing population and a growing economy will lead for a demand for higher defences in many places, independent of climate change. Globally, these protection costs could be up to \$10 billion per year over the coming decades (less than 0.01 % of global GDP). These costs are included in the estimates below.

2) World Bank regions account for at least 55 % of the total adaptation costs.

Under low to high sea-level rise scenarios, global protection costs range from \$21-\$60 billion per year over the coming decades. World Bank regions with the highest cost include Latin America and the Caribbean, followed by East Asia and the Pacific Region. The regions with the lowest cost are the Middle East and North Africa. Dikes are responsible for around four fifths of the total capital cost of defences.

3) Increases in cyclone intensity only had a relatively small influence on the cost of protecting the coast.

Globally, costs were increased only by 8-9 % compared with the equivalent scenario without cyclones. Even in World Bank regions where cyclones are prevalent, such as East Asia and Pacific and South Asia, dike costs only rise by 13 % in the 2040s.

4) Protection costs are likely to increase over time as dikes must be maintained to remain effective.

Sea and river dike maintenance costs (not reported in Figure 2, but estimated at 1% and 0.5% of capital costs respectively following reported practise) increase approximately linearly throughout the study period, with costs increasing 4.2 times from the 2010s to 2040s to \$7.9 billion per year. This can represent significant increased expenditure, and should be considered in long-term planning, including beyond the time period analysed here as sea levels will continue to rise beyond 2050. The cost estimate is a minimum as we did not consider the maintenance of the dikes built prior to our 1995 model baseline, which will have significant additional maintenance costs

Maximising benefits and appropriate adaptation options

From a strategic planning perspective, protecting the coast often happens where it is cost efficient to do so: That is, where overall damage costs via protection are greater than the expense of adapting to any residual damage. On a global scale, the benefit to cost ratio suggests that adaptation is a worthwhile investment: It not only protects the coastal zone, but also benefits infrastructure networks that are linked to it.

This study only investigated capital costs of dike building and nourishing beaches, plus associated dike maintenance costs, but other forms of protection and adaptation are available. These methods may be more cost effective or appropriate depending on the local situation, but are difficult to model at global scales. Thus engineers have a wider range of options to consider, integrating into wider coastal zone management and coastal change. These need to be evaluated at a small scale or by a case-by-case basis to determine cost-effective adaptation measures that are affordable, plus socially and ecologically appropriate for different settings. For instance, Dutch engineers operate a 'Building with Nature' approach creating integrated and flexible protection solutions, that help boost the

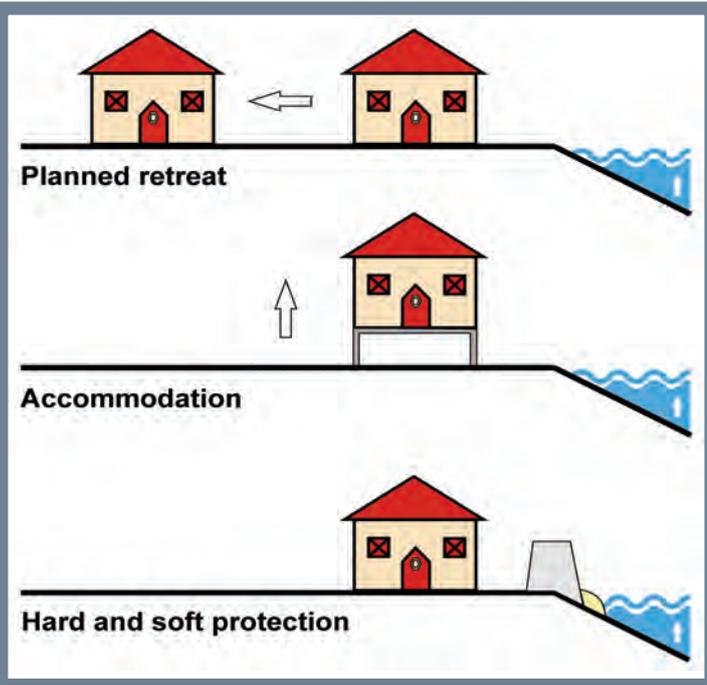


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Robert J Nicholls focuses his research on to managing and adapting to the consequences of coastal change, particularly flood and erosion management and climate change. He is interested in large-scale morphological behaviour and the integrated assessment of coastal areas. Robert is professor of coastal engineering at the University of Southampton. He led the coastal chapter of the 4th Assessment Report of the IPCC (2007).

Figure 1. Retreat-accommodate-protect adaptation options as sea levels rise



Next steps

What are the next steps to understanding and strategically planning for damage caused by climate change and sea-level rise, and associated adaptation costs? For developing nations, there is funding for adaptation, protection and resilience against climate change which was initialised under the auspices of the Kyoto protocol. One such programme is the Pilot Program for Climate Resilience aiming to integrate climate risk with development planning and its implementation shifting away from a 'business-as-usual' approach to broad-based country-level strategies of climate resilience. For instance, funding has recently been granted to improve coastal embankments, coastal resilient infrastructure and promote climate resilient agriculture and food security and in Bangladesh. These projects often have dual benefits (e.g. reduce flood risk and improve food security), whilst providing a long-term investment in country's future.

Conclusions

With relative sea levels continuing to rise, and expected to accelerate, we will hear increasing reports of how extreme water levels effect livelihoods. Engineers have the opportunity to do something about this, and the results from the World Bank study by Nicholls et al. (2010) suggest that the financial costs of adapting are going to remain high. However, building defences is not the only answer, and engineers can work with communities to determine the optimum way to increase resilience and to adapt, potentially via protection, to rising sea levels and other coastal change over long time-scales. One such project undertaking this in Bangladesh and the Ganges-Brahmaputra delta is the ESPA Deltas programme, and this research project is discussed in the next article.

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economy, are environmentally friendly and sustainable, whilst making the country a safe place to live (De Vriend and Van Koningsveld 2010). Whilst the Dutch are frequently exhibited as a model of good practice and robustness in protecting the coast, other nations may not want to or be able to afford to protect. It is these nations that remain vulnerable and alternative, innovative forms of adaptation to sea-level rise may need to be considered. Simultaneously, the natural environment is also important to consider and preserve, as noted in Europe through various EU directives. Indeed, in many developing countries it is the natural environment (e.g. mangroves) that is the first

line of defence against extreme water levels.

Finally, climate change and sea-level rise are often blamed, not just by the general public, but also within science as the main cause of future coastal disasters. Disasters from extreme water levels have occurred well before climate change was mainstream. Today, in our increasingly urbanised lifestyle, it is the combination of increased infrastructure, investment and people living on the coast that make the coastal region vulnerable (e.g. Kron 2012). Thus man's direct management and influence on the coast is as important as any local sea level rise.

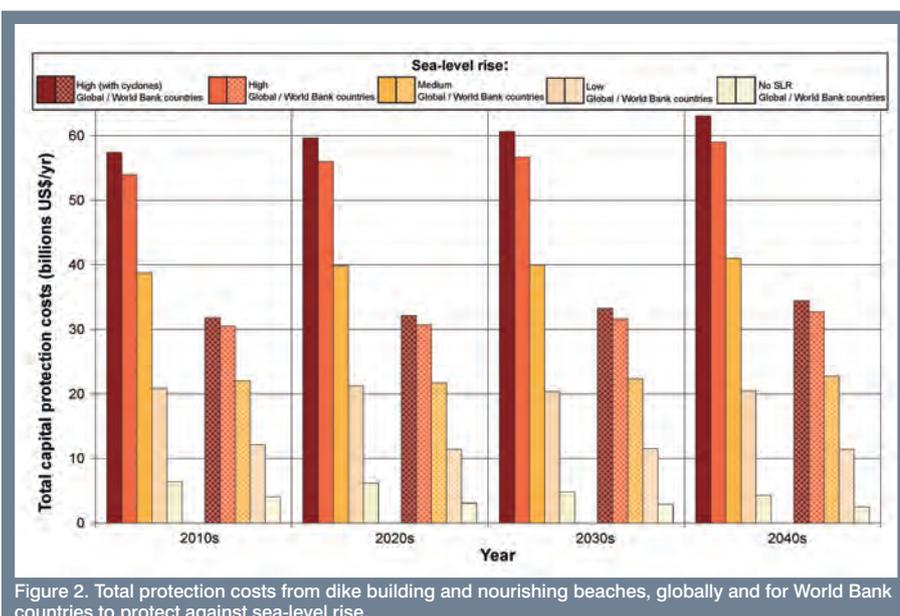


Figure 2. Total protection costs from dike building and nourishing beaches, globally and for World Bank countries to protect against sea-level rise.

SEA LEVEL RISE IN MALAYSIA

BY NOR ASLINDA AWANG & MOHD RADZI BIN ABD. HAMID

Although the global prediction for sea level rise is about 1.7 – 3.1 mm/year, the regional sea level rise in Malaysia is expected to be higher, owing to local climate and topographical conditions. Low-lying areas with high population and socio-economic activities are at risk of being inundated. Malaysia has a long shoreline with most of the cities located near the coast, and NAHRIM has carried out a number of studies as our preparation to face global warming issues in terms of projections for sea level rise in Malaysia, and production of Potential Sea Level Rise (SLR) Inundation Maps and Coastal Vulnerability Assessments for high risk areas. These Potential SLR Inundation Maps can be used as a guide for planning and implementation agencies such as the Department of Town and Country Planning (JPBD), the Drainage and Irrigation Department (DID), the Public Works Department (PWD) and Local Authorities in their development and adaptation planning, avoiding massive development in critical areas.

Introduction

Until quite recently, climate change and global warming were foreign words to us. However, thanks to climate change scientists from all over the world and their research findings, some of us are now more aware that global daily temperature is increasing (Karl *et al.*, 1991), and these phenomena are believed to be the reason why natural disasters such as floods, droughts, landslides, hurricanes and storm surges are more frequent than previously. The International Panel on Climate Change (IPCC, 1995) reported that the global mean surface air temperature has increased by 0.5°C in the 20th century and is projected to increase further in this century, i.e. between 1.5 to 4.5°C. These temperature changes will have many negative effects, including greater frequency of heat waves; increased intensity of rain events and storms, floods and droughts; rising sea levels; a more rapid spread of disease; rising number of natural disasters and casualties due to landslides and loss of biodiversity (McLean, 2009).

Rising sea levels also pose a particular threat to countries with high population and socio-economic activities in the coastal regions. Church *et al.* (2001) predicted a sea level rise (SLR) of 0-1 meter during the 21st century.

According to Dasgupta *et al.* (2007), three main factors contributing to the rising seas are: ocean thermal expansion; melting of the Greenland and Antarctica glacier and ice sheets; and changes in terrestrial storage, with ocean thermal expansion as the dominant factor. However, new data on rates of deglaciation in Greenland and Antarctica suggest greater significance for glacial melt, and a possible revision of the upper-bound estimate for SLR in this century. Since the Greenland and Antarctic ice sheets contain enough water to raise the sea level by almost

70 m, small changes in their volume would have a significant effect (Dasgupta *et al.*, 2007).

Bindoff *et al.* (2007) estimates the global mean sea level rise rate to be 1.8 ± 0.5 mm/yr for the period of 1961-2003, and 1.7 ± 0.5 mm/yr over the 20th century while Casenave and Nerem (2004) estimate the rate of sea level rise as 3.1 ± 0.7 mm/yr, based on satellite altimetry observations for the period of 1993 to 2003. Large variations in sea level rise were observed in the western Pacific and eastern Indian Ocean, mainly due to ocean circulation changes

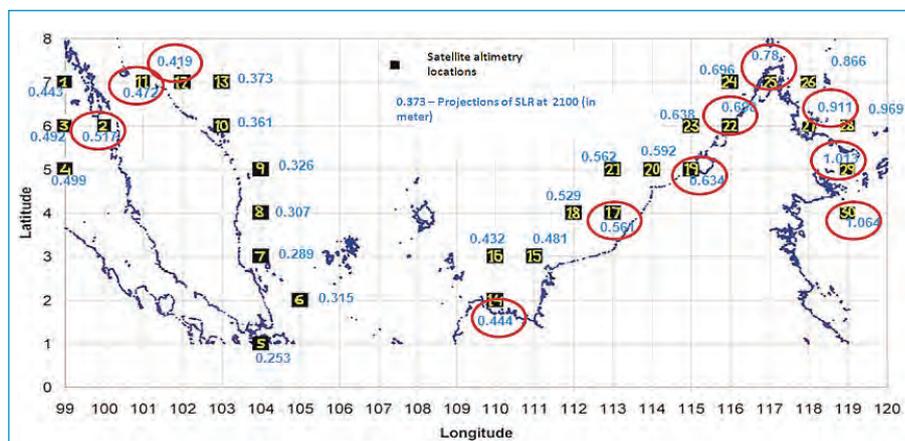


Figure 1: Projected mean sea level rise along the coast of Malaysia for year 2100. Red circles indicate values higher than 0.4 m rise (Source: NAHRIM, 2010).

Station No.	Location	Latitude	Longitude	SLR Rate (mm/year)
1	Sempadan Malaysia (Perlis) - Thailand	6	100	6.08
2	Sempadan P.Pinang - Perak Border	5	99	6.45
3	Perairan Laut Andaman	1	104	3.87
4	Perairan Selat Melaka	2	105	3.68
5	Selat Johor	3	104	2.88
6	Perairan Mersing	4	104	2.73
7	Pulau Tioman	5	104	2.78
8	Persisiran Pantai Pekan	6	103	3.46
9	Cherating	7	103	3.49
10	Pulau Perhentian, Terengganu	7	102	4.29
11	Sempadan Malaysia (Kelantan) - Thailand	7	101	5.20
12	Perairan Tumpat	6	99	5.70
13	Perairan Kelantan	7	99	5.02
14	Perairan Kuching dan Bau	4	113	4.74
15	Perairan Sejingkat (Sibu)	2	110	4.00
16	Perairan Sibu	5	115	5.37
17	Perairan Miri	6	116	5.23
18	Perairan Bintulu	7	117	5.06
19	Perairan Brunei	6	118	5.57
20	Luar Persisir Sabah - Sarawak - Brunei	5	119	6.28
21	Luar Persisir Sabah - Sarawak - Brunei	4	119	7.00
22	Persisiran Pantai Kota Kinabalu	7	118	5.25
23	Pulau Labuan	6	119	5.64
24	Persisiran Pantai Tuaran - Kota Belud	7	116	5.17
25	Teluk Marudu, Kota Marudu - Kudat	6	115	5.27
26	Perairan Pitas	5	114	5.11
27	Perairan Sandakan	5	113	4.84
28	Laut Sulu	4	112	4.51
29	Perairan Lahad Datu	3	111	4.13
30	Perairan Tawau	3	110	3.82

associated with El Niño–Southern Oscillation or El Niño/La Niña–Southern Oscillation (ENSO) events (Church et al., 2006).

Sea level change varies spatially with some regions showing higher rates compared to the global mean sea level rise while sea level in other regions is falling, probably due to regional thermal expansion (Cazenave and Nerem, 2004). The increase in occurrences of extreme high water due to storm surges and variations in the extremes related to mean sea level rise in the regional climate are also evident (Bindoff et al., 2007).

Projection of Sea Level Rise in Malaysia

The Study of the Impact of Climate Change on Sea Level Rise in Malaysia (NAHRIM, 2010) was carried out in 2010, to project SLR in the Malaysian coast for the year 2100. Using linear trend analysis, satellite altimetry data (1993 – 2010) from 30 stations around Malaysia (Figure 1) were analysed to obtain the rate of SLR for Malaysia. These values were then assimilated with the results from 49 simulations of 7 Coupled Atmospheric–Oceanic General Circulation Model (AOCGM) for SLR projections along the coast of Malaysia (NAHRIM, 2010). The results showed that:

- (i) There is a significant increase in SLR trend over the recent 5 years, compared to the SLR trend over 20 years ago;
- (ii) The observed Mean SLR rate along the

Malaysian coast (based on satellite altimetry data from 1993 – 2010) is between 2.7 – 7.0 mm/yr.;

- (iii) In Peninsular Malaysia, the projected SLR for the year 2100 is 0.25 – 0.5 m with the maximum value occurring in low-lying areas along the Northeast and West coast of the peninsular (Kelantan and Kedah);
- (iv) In Sabah, the projected SLR for the year 2100 is 0.69 – 1.06 m with the maximum value occurring in low-lying areas, river mouths and estuaries in the East coast (Tawau, Semporna, Lahad Datu, Sandakan and Kudat); and
- (v) In Sarawak, the projected SLR for the year 2100 is 0.43 – 0.64 m with maximum value occur in low lying areas, river mouths and estuaries in the Southwest coast (Meradong, located between Batang Igan and Batang Rajang).

Table 1 shows the rates of SLR along the coast of Malaysia based on observed satellite altimetry data from 1993 – 2010 while Figure 1 shows the projected mean sea level rise for the Malaysian coast in the year 2100.

Impacts and Adaptation Measures

Climate change and sea level rise can give rise to high impacts such as destruction of assets and disruption to economic sectors, loss of human lives, mental health effects, or loss on plants, animals, and ecosystem and their severity depends on their extremes, exposure and vulnerability (IPCC, 2012; McLean, 2009). Sea level rise may reduce the size of an island or



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state and its' infrastructure i.e. airports, roads, and capital cities, which normally predominate in the coastal areas; worsen inundation, erosion, and other coastal hazards; threaten vital infrastructure, settlements, and facilities; and thus compromise the socio-economic well-being of the island communities and states (Handmer et al., 2012)

The magnitude of tropical cyclones often governs the magnitude of damage due to storm surge (Xiao and Xiao, 2010). Suzuki (2009) projected the changes in storm surge and associated damage for three major bays in Japan, namely Tokyo, Ise, and Osaka, based on the calculation of inundations for different sea levels and different strengths of typhoons, using a spatial model with information on topography and levees. His results indicate that a typhoon with the strength of 1.3 times higher than the design standard, combined with a 60 cm sea level rise in the investigated bays will cause damage of about USD 3, 40, and 27 billion, respectively.

Warming of the ocean surface will give impacts to the biodiversity and the growth rates of species that are sensitive to temperature such as corals (Handmer *et al.*, 2012). They reported that damage to structures, infrastructure, and crops during tropical cyclones and water shortage are the main impacts from climatic extremes in the tropical regions. On atolls, storm surges, high wave events and 'king' tides would bring a serious problem of salinisation of the freshwater. Therefore, awareness, improved governance, proper development and preparedness are very important in coping with climate change impacts in developing countries (Handmer *et al.*, 2012).

Although risks cannot be fully eliminated, disaster risk management and adaptation to climate change are very important to reduce exposure and vulnerability, and increase resilience to the potential adverse impacts of climate extremes (IPCC, 2012). Furthermore, adaptation and mitigation will complement each other hence reducing the risks of climate change significantly (IPCC, 2012). Some of the alternative methods recommended by the Malaysian Drainage and Irrigation Department's Manual (DID Manual, 2009) to mitigate the damage of coastal storms and forces are accommodation, protection, beach nourishment, retreat; do-nothing; integrated shoreline management plan, and refurbishment on coastal bund.

Based on the SLR Projections mentioned earlier, NAHRIM then carried out Desktop Studies on four (4) selected high risk areas along the coast of Malaysia, i.e. Kedah Estuary, Terengganu Estuary, Kota Kinabalu, Sabah and Sarawak Estuary. Using Numerical Modeling Suite and GIS Software, Potential SLR Inundation Maps were produced to assess the impact of SLR towards the population, development and the road systems that exist within these areas.

Figure 2 shows Potential SLR Inundation Maps for Kedah Estuary. These Potential SLR Inundation Maps may be used as guides for planning and implementation agencies such as the Town and Country Planning Department, the Drainage and Irrigation Department, the Public Works Department and Local Authorities in their development and adaptation planning; minimising massive development in critical area, hence reduce the impact of SLR towards the country's population and it's socio-economics well-being (Nor Aslinda *et al.*, 2012).

Way Forward

SLR has the potential to change coastal natural processes, marine habitats and ecosystems, which will affect the infrastructure and thence the socio-economy of Malaysia. These impacts or disasters may be minimized or avoided with knowledge and preparedness.

Since the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) is now underway and is expected to be finalized in 2014, NAHRIM intend to revise the existing SLR Projections along the coast of Malaysia, based on the new findings of AR5. A lot of detailed studies will have to be undertaken in Malaysia on climate change and sea level rise related issues such as the potential inundation maps for sea level rise in other critical

locations throughout Malaysia, vulnerability index for sensitive areas, assessment of potential impacts of climate change on other vulnerable sectors such as agriculture, forestry, biodiversity, water resources, coastal and marine resources, public health and energy. The findings from these studies will be incorporated into existing or new policies so that all development or infrastructure planning and activities will be implemented in a sustainable manner with less disaster risks towards the human population.

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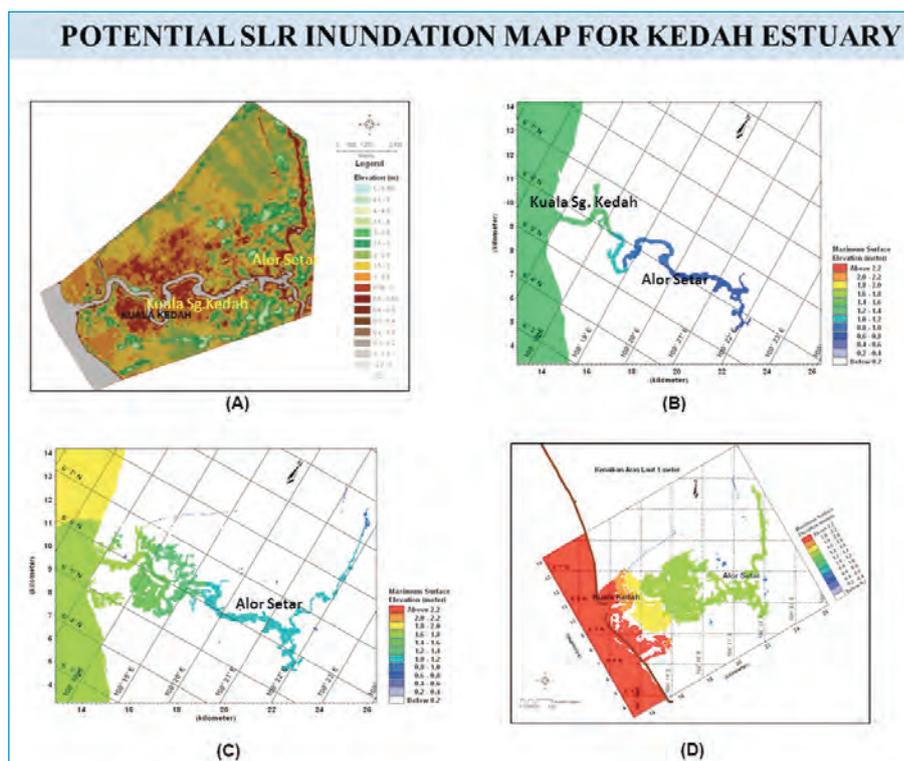


Figure 2: (A) Existing Topography of Kedah Estuary study area of 70 km²; (B) Existing SLR Inundation Map (0 m); (C) Potential Inundation Map with 0.5 m SLR; and (D) Potential Inundation Map with 1.0 m SLR (Source: Nor Aslinda *et al.*, 2011)



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I direct the Hydro-environmental Research Centre, at Cardiff University, which currently comprises over 40 research staff and students. I Chair the UK Research Excellence Framework 2014 Civil Engineering Sub-Panel and am currently involved in a wide range of research projects as given on my website

Statement

If elected to continue to serve as IAHR President, then I believe our overriding goal has to be to make IAHR more appealing and attractive to practitioners and engage more with leading water research organisations and consulting companies etc. With this in mind, I wish to build on the following strengths and consolidate new initiatives I have introduced over the past two years:

- Maintain JHR as our flagship research journal, supporting maintenance of quality;
- Develop our new practitioner-based Journal of Applied Water Engineering and Research JAWER;
- Continue to work with the Editor and our new Advisory Board of Practitioners to make Hydrolink focused on special topics, of interest to the wider hydro-environmental community;
- Develop and support new task groups which are topical and appealing to practitioners, such as Flood Risk Management;
- Develop new strategic partnerships with other allied water associations, such as hosting activities like the Global Water Security Forum at the Chengdu Congress;
- Support the activities of Student and Young Professional groups, ideally bringing these together;
- Collaborate with the IAHR team to build on our encouraging membership growth, which has increased from just over 2,000 to 3,000 over the last two years.

I believe that these are exciting times for IAHR and I would welcome the opportunity to develop these initiatives further over the next two years.

For Vice-President APD

Prof. Zhaoying Wang

Professor of Tsinghua University &
Chairman of the Advisory Council
of UNESCO International Research
and Training Center on Erosion and
Sedimentation, China



Zhaoyin WANG is professor of Tsinghua University and the chief editor of the International Journal of Sediment Research. His research interests include sediment transportation, vegetation-erosion dynamics, stream ecology and integrated river management. He has published 320 papers in international and Chinese journals. He was invited and delivered 21 keynote and invited lectures at international conferences.

Dr. Wang made contributions to IAHR through:

- Encouraged scientists and students to participate IAHR congresses and symposia.
- Organized IAHR conferences, including 8th IAHR Symposium on Stochastic Hydraulics, 29th IAHR Congress, and 7th IAHR Symposium on River, Coastal and Estuarine Morphodynamics.
- Initiated and worked as associate editor of the IAHR journal "International Journal of River Basin Management" and initiated and worked as advisor of the IAHR-APD journal "International Journal of Hydro-environmental Research".
- As the vice president and chairman of the Hydro-environment Division of IAHR he reported activities of the division committees to the council and EC meetings.
- As the chairman of the International Scientific Committee he is organizing the 35th IAHR world congress.

For Vice-President Americas

Dr. Marian Muste

Research Scientist at IIHR-
Hydroscience & Engineering, Civil
& Environmental Department, The
University of Iowa, Iowa City, U.S.A.



Dr. Muste holds a Civil Structural Engineering degree from the Polytechnic Institute Cluj-Napoca (Romania) and MS and PhD degrees in Civil & Environmental Engineering from The University of Iowa (U.S.A.).

Currently, he is a research engineer with IIHR-Hydroscience & Engineering (formerly known as Iowa Institute of Hydraulic Research) and adjunct faculty in the Civil & Environmental Engineering and International Programs Departments.

If elected, I will continue to collaborate with IAHR colleagues within a strategy driven by practical finalities. My major target for the next term will be the consolidation of the current organizational structure and the engagement of the Student and Young Professional chapters in synergistic collaboration that will beneficially impact our organization as a whole. I will continue to lead actions that add international dimension to student and young professional activities between congresses. As a member of the core group that will deliver a series of WMO training courses in hydrometry, I will also act as a IAHR messenger and mentor for professionals from different parts of the world, with emphasis on countries in Latin America, Asia and Pacific and Africa.

I hope to stimulate activities which enhance the visibility and importance of IAHR to lead, stimulate and facilitate dialogue among water researchers, educators, and practitioners in their quest for solving the challenges faced by water resources in the 21st century.

For full candidate's profile, go to iaahr website:
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=729>

Council Member (Europe) 5 candidates for 3 open positions



Michele Mossa *

Full Professor of Hydraulics
Technical University of Bari
D.I.A.S.S.
Italy

2 candidates for 1 position



Anton Schleiss

Laboratoire De Constructions
Hydrauliques,
Ecole Polytechnique Fédérale,
Lausanne, Switzerland



Hovhannes Tokmajyan

Rector, Yerevan State University of
Architecture and Construction,
Armenia

2 candidates for 1 position



Damien Violeau

Laboratoire National D'Hydraulique
Et Environnement (LNHE) EDF R&D,
Chatou, France



Silke Wieprecht

Prof. At Institute for Modeling
Hydraulic and Environmental
Systems, Stuttgart University,
Germany

* re-eligible for second term

2013 COUNCIL ELECTIONS SLATE OF CANDIDATES

For Vice President Europe 2 candidates for 1 position

Prof. Philippe Gourbesville

Professor and Director of Polytech Nice Sophia, University Nice Sophia Antipolis, France



Philippe Gourbesville is, since 2007, the Director of Polytech Nice Sophia and professor of Hydroinformatics and Water Engineering, at the University which is the first group of engineering schools in France. He is a visiting professor at various European and international universities. After graduating from Strasbourg University, France, Philippe has spent 12 years in a water consulting company as project manager before joining the University of Nice Sophia Antipolis, France in 1997. Since 2004 and under the Erasmus Mundus, Philippe has developed the first joint master degree EuroAqua focused on Hydroinformatics and water management with 5 European leading universities.

If elected, my actions will be focused on the following:

- Promote innovation by attracting industrial companies which are interested and active in the water domain but not represented in IAHR and connecting practice with research
- Increase the value of IAHR for Institute Members through the development of a problem oriented approach/organization, the publication of reference documents by the sections ...
- Develop collaboration with sister scientific organizations at national or international level, and promote co-sponsorship of events.
- Promote involvement of students and young professionals by developing specific actions targeting those two communities which represent the future of IAHR.
- Promote knowledge sharing and transfer by expanding IAHR's online electronic library and by introducing ebooks, wikis and forums.

For full candidate's profile, go to iaahr website:
<http://www.iahr.org/site/cms/contentviewarticle.asp?article=725>

Prof. Arthur E. Mynett

Professor of Hydraulic Engineering and Head of Water Science and Engineering Department at UNESCO-IHE Institute for Water Education, Delft, The Netherlands



Arthur Mynett has long been contributing to IAHR in various capacities. He was actively involved in specialist working groups and served for over a decade as secretary and chairman of the IAHR-IWA-IAHS Joint Committee on Hydroinformatics. He stimulated cross-links within IAHR as well as with other associations outside. He served as Division Chair and has been elected on Council since 2005.

As professor at UNESCO-IHE, Delft University of Technology, and the Chinese Academy of Sciences he has stimulated many young researchers from all over the world to contribute to IAHR's regional and global conferences. His working experience of over 30 years with Delft Hydraulics enables him to convey the practitioners' needs and promote IAHR in international fora. Prof. Mynett is in charge of organizing the IAHR World Congress 2015 in the Netherlands.

Statement

"The future of IAHR is with the young generation of hydro-environment professionals; they deserve a prominent role within our association. Externally, we need to strengthen our position and align our activities with other associations. I see a stronger role for IAHR in continuous professional education, and an obligation to reach out towards the developing world. Increased membership and sound financial policies are crucial to secure the future of our association. As Vice-President I intend to enhance our role in the global hydro-environment arena".

For Secretary-General

Dr. Ramón M. Gutiérrez Serret

Director of the Maritime Experimentation Laboratory of the CEDEX "Centro de Estudios Hidrográficos", in Spain, Ministry of Environment, Spain



Dr. Gutiérrez graduated in Civil Engineering from the Polytechnic University of Madrid in 1978, and was awarded a doctorate from the same institution in 1994. From 1978 until 1998 he worked as an engineer in the Hydraulic Studies and Planning Department of the CEDEX "Centro de Estudios Hidrográficos", in Spain, occupying different posts including finally Head of Department. From 1998 until now he is the Director of the Maritime Experimentation Laboratory of CEDEX. He has also served as Associate Professor at the Madrid Polytechnic University. He has published numerous papers related to hydraulic structures and maritime works. In 2007, he received the Spanish decoration of the Order of Isabel La Católica, for services to foreign administration. He has been IAHR Secretary General since 2005.

I plan to engage in the following activities:

- To ensure a proper execution of collaboration between IAHR and CEDEX, acting as link between both institutions, especially for the development of a new agreement post 2015.
- To increase the number of members—especially institute (especially), improve IAHR finances and provide better services to members, with special emphasis on increasing:
 - Specific agreements with national water and hydrotechnical associations
 - The participation of professional engineers and others practitioners
 - The participation of students, professional engineers and research workers who have recently graduated.

YOUR VOTE COUNTS!

The IAHR Council Elections are open until Wednesday, September 11th. All IAHR Members have been invited to vote by electronic ballot. If you wish to vote and have not received a ballot or have lost your ballot, please contact Elsa Incio at membership@iahr.org or visit the website at www.iahr.org!

Council Member (Asia and Pacific) 3 candidates for 3 positions



James Ball *

University of Technology Sydney
Faculty of Engineering
School of Civil and Environmental
Engineering
Australia



Hitoshi Tanaka

Chair of the IAHR Asia & Pacific Division
Dept. of Civil Engineering,
Tohoku University
Japan



Jing Peng

Division of International
Cooperation
China Institute of Water Resources
and Hydropower Research
China



Arturo Marcano *

CVG EDELCA
Hidroeléctrica Macagua
Departamento de Hidráulica
Venezuela



Angelos Findikakis

Bechtel National Inc.
USA

* re-eligible for second term

EVOLUTION OF HYDROINFORMATICS IN MURRUMBIDGEE RIVER COMPUTER

BY STEFAN SZYLKARSKI & TERRY VAN KALKEN



Stefan Szylkarski is a Group Director with DHI and a civil engineer with over twenty years of experience in hydraulics and environmental engineering in water environments. He has worked extensively with DHI in the application of hydrodynamic models, decision support and integrated hydroinformatic software systems for planning and real time management of regulated rivers systems.



Terry van Kalken is a Technical Director at DHI. He has 25 years' experience in the development and application of hydrodynamic models for water resources and flood risk. Following an MSc in Computational Hydraulics at IHE Delft in 1988, he worked initially at DHI in Denmark in the MIKE 11 development team, and subsequently on projects in Asia, Latin America, Africa, UK, Europe and New Zealand. He is currently CARM project manager, based in Brisbane, Australia.

Hydroinformatics

The Hydroinformatics industry is a growing branch of informatics which integrates digital information and communication technologies, numerical modelling in a decision support framework to solve problems in water environments, including hydrologic, hydraulic and environmental systems. Hydroinformatics grew out of the earlier discipline of computational hydraulics and was foreseen more than 20 years ago (Abbot et al, 1991) as a natural progression of the 4th generation hydraulic modelling systems that were emerging at the time, and which are in common engineering practice today.

The management of waters in large river systems is a key area where hydroinformatics is being applied today and in recent times has experienced significant evolution.

Hydroinformatics in river management provides support for decision-making in planning and operations of river systems to address increasingly serious problems in the equitable and efficient use of water. River management has traditionally utilised conceptual hydrology approaches as the basis for decision making tools. However, computational hydraulics remains as the core technology of hydroinformatics. As river management continues to evolve into hydroinformatics, the tools applied in river management are shifting towards computational hydraulics at the core and augmented with the traditional and complementary technologies including meteorology, hydrology, optimisation and eco-hydraulics.

Decision Support Processes in River System Management.

Within the area of river management there are two very distinct requirements for a decision support system (DSS) in the management of waters within a river basin; the basin *planning* process and the river operations process.

The river basin planning process requires data, models and analytical tools to support decision-making in terms of allocating water to competing users over long periods of time into the future. The DSS supports the making of **value judgments** and the trade-offs between

social, environmental and economic uses of the water in a river basin. The DSS will therefore incorporate tools and methods suited for analysing high level system behaviour; it utilises conceptual model of complex processes and incorporates tools that focus on **uncertainty** and **trade-offs** between overall allocation of water to different users. The system is, in general, data driven with simplified conceptual and empirical models for forecasting future behaviour using historical or long term forecast data for time spans in the order of decades. The DSS used in this process is therefore an offline and stand-alone system similar in nature to the traditional modelling and planning approach.

The river basin operational process requires support for real time decision making in terms of settings for water infrastructure such as valves, gates, weirs and pumps. The DSS supports the operator in making very specific and exact settings for infrastructure in the river basin spanning the coming hours and days. The objective of the DSS is to provide an optimised system setting for all dam and regulated water releases so as to meet the near future demands as efficiently as possible. The operational DSS will therefore require large amounts of real time data and physics based models that precisely predict water flows and process in the system.

The models required for an operational DSS are by nature highly parameterised, a necessary requirement if oversimplification of the complex river processes is to be avoided and to ensure precise decisions can be made on a sound physical basis. The operational DSS combines vast amounts of real time hydrological and hydraulic data, and continuously updates operational forecasts based on the most current river state. This requires a high level of automation and sophistication in operational Information Technology.

The concept of different systems supporting the planning and operation of river basins is analogous to the flying of a modern airliner. The route planning process uses a specific software tool that produces a flight plan which balances value judgments and trade-offs between risks, resources schedule and economy. Once the plane is airborne the pilot acts as the flight

RIVER MANAGEMENT AIDED RIVER MANAGEMENT (CARM)



Figure 1 - Schematic of the Murrumbidgee River System

operator and flies the plane as close to the flight plan as possible, supported by the plane's flight control system, which is effectively a DSS. This system receives hundreds of pieces of information from sensors all over the aircraft which are interpreted in real time and applied through the pilot's actions to trim the plane continuously so as to optimise fuel efficiency while at the same time ensuring stability and safety. By analogy, a river basin planning DSS can be said to produce the "flight plan", while an operational DSS is a support tool for the "pilot".

The Role of Models in River Management

"A complete physically-based synthesis of the hydrologic cycle is a concept that tantalizes most hydrologists" (Freeze and Harlan, 1969)

In the original blueprint for a complete hydrological cycle model by Freeze and Harlan, it was argued that if each of the component processes within the hydrological cycle can be described by an exact mathematical representation then it should be possible to model the different flow processes using their governing partial differential equations. Interestingly, they put forth, a set of questions that must be answered before such a framework would be successful which

can be paraphrased as follows; 1. Do we have the science? 2. Do we have the data? 3 Do we have the computational resources? The answer today to all of these questions is most commonly in the affirmative.

River basin planning and management has traditionally relied on simplified and conceptual hydrological approaches to investigate and forecast water movement on large spatial scales and timescales of tens to hundreds of years. In order to be able to simulate such long periods, hydrological models simplify the complex flow behaviour processes and produce average flows at daily or monthly time intervals. The simplifications were traditionally made out of necessity due to a historical combination of lack of science, data and computation resources. However, in today's rapidly evolving digital world these traditional approaches are over simplified and do not make use of all available information, science and resources. The question that must be answered is whether our decision processes are sub optimal if we do not make use of all available data.

Over-simplification of the physical processes in contrast is fraught with difficulties. This has been recognised for some time. D'Alembert, an 18th century contemporary of both Bernoulli and Euler, while working on the new mathematical

formulations describing observations in fluid mechanics, was noted to lament: (Rouse and Ince, 1957)

"If it happens that a question we wish to examine is too complicated to permit all its elements to enter into the analytical relation we wish to set up, we separate the more inconvenient elements, we substitute for them other elements less troublesome, but also less real, and then are surprised to arrive, notwithstanding our painful labour, at a result contradicted by nature; as if after having disguised it, cut it short, or mutilated it, a purely mechanical combination would give it back to us."

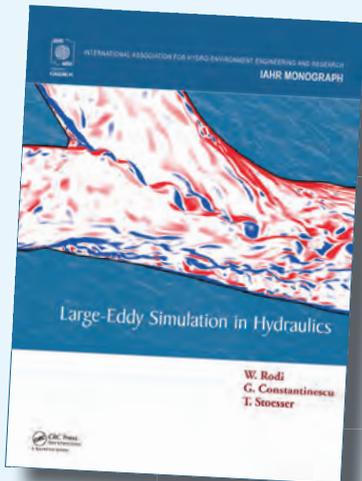
River operators work on forecast horizons much shorter than river planning manager require forecasts looking forward the next few hours, days or weeks. River operations using planning style models based on simplified hydrological approaches ignore important river processes such as channel and floodplain storage, flow dependent travel time and groundwater interactions.

In the modern digital world the three key requirements laid out by Freeze and Harlan can by and large be met. The timescales over which river operators work is relatively short, the advent of remote and low cost sensing and monitoring provides a dazzling array of information and the physics based models have been tuned and optimised to efficiently simulate physics based water movements. The tantalizing prospect of deterministic modelling in river operations can therefore be achieved with confidence and the industry must move in this direction.

The Murrumbidgee River Computer Aided River Management (CARM) system is one of the significant evolutions of physics based model decision support systems in river operations. It's application will demonstrate this evolution and represents the future direction for river operations dss.

The Murrumbidgee Computer Aided River Management System (CARMs)

The Murrumbidgee River basin covers 84,000 square kilometres forms the largest catchment in the southern connected Murray Darling Basin



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(MDB). The river flows 1000km westward from the catchment headwaters to the Murray River. The average annual rainfall ranges from over 1,700 millimetres in the alpine areas of the Snowy Mountains, to less than 350 millimetres on the semi-arid western plains. Evaporation displays an inverse picture, varying from less than 1,000 millimetres per year in the south-east, to over 1,800 millimetres per year in the west. Major water storages in the headwaters comprise Burrinjuck Dam (1028 GL) and Blowering Dam (1628 GL). River operations are augmented by a series of 6 in-river regulators (weirs) and on off-stream storage reservoir at Tombullen.

State Water Corporation is responsible for bulk water deliveries and river operations in New South Wales (NSW). The daily operation of the river is a complex task that needs to take into account not only the thousands of individual water users but also a range of catchment and river processes that are difficult to quantify. Water once released from the dams takes up to four weeks to travel down the system. Current river operations rely heavily on the experience and judgment of the river operator and are based on simple water balance modelling concepts. The long travel times coupled with dynamic river behaviour and unpredictable future weather conditions leads to significant uncertainty in the volume and timing of dam releases. As a result of the many uncertainties in quantifying the real inflows and extractions to and from the river, the river operator is usually conservative when computing the daily dam releases, with the end result that often more water is released than is needed to satisfy all demands, which affects the future reliability of supply.

As part of a programme to modernise the current operations, State Water have embarked on a US\$65m upgrade of the river management and operational system for the Murrumbidgee River that sets a benchmark for efficient river operations in Australia and internationally. The Murrumbidgee River Computer Aided River Management system (CARMs) is an example of an operational DSS in river basin management. The recent recipient of the Australian Water Association's National Award for Innovation in Water Infrastructure, CARMs represents the future direction of contemporary DSS in operational river management.

CARM is true to the vision of the role of hydroinformatics in supporting decision making as envisaged more than two decades ago. The CARM system integrates real time data, hydro-

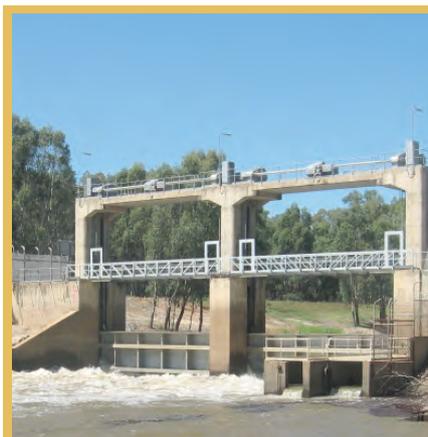


Figure 3a - Yanco Weir, Murrumbidgee River



Figure 3b - Telemetered Water Meter

logical and hydraulic models in a Decision Support framework customised for real time river operations (van Kalken et al, 2012). Real time data feeds include observed and forecast catchment rainfall, river extractions, river flows and levels and dam and regulator gate settings. Real time extraction metering forms a key component of the CARM project and is being realised through the installation of over 700 new flow meters providing real time water extraction information to river operators for the first time (see Fig. 3b). Catchment runoff flows are forecast using rainfall-runoff models, utilising both rainfall observations and Bureau forecasts. These are fed into a hydrodynamic river simulation model that accurately simulates the river behaviour, including flow dependent travel time, channel and weir storage. The hydrodynamic model assimilates the measured river flows and levels to update the river state prior to generating forecasts. Near-river bank and groundwater exchanges, as well as evapotranspiration along the riparian margin, are simulated using an integrated surface groundwater interaction model, fully coupled to the hydrodynamic river model.

CARM incorporates an optimisation tool which

updates the settings for the dam releases and the downstream re-regulation weirs several times a day. The optimisation recognises system constraints such as channel capacities and desired flow rates of change, and operates with the objective to meet all water demands while at the same time minimising releases from the headwater storages.

The CARM DSS integrates all measured and modelled data with a range of custom tools to allow the operators to check and verify data and results.

Conclusions

The rise of hydroinformatics as the natural progression from computational hydraulics embedded in common hydraulic modelling software was foreseen more than 20 years ago. Advances in information technology, data acquisition and processing and computational power have all contributed to the realisation of the hydroinformatics vision.

The development of DSS in river management is the realisation of the hydroinformatics vision in river management. DSS in river management can be broadly classified into two distinct types supporting river basin planning over long timescales or conversely river operations over shorter timescales. The requirements for the underlying numerical tools are also different, with river basin planning being undertaken over large spatial and temporal timescales, which ultimately leads to the necessary simplification of short term processes. Conversely, river operations requires precise knowledge of the dynamic river and catchment processes on which to base robust decisions, and these cannot be adequately resolved with simplified approaches.

The Murrumbidgee River Computer Aided River Management (CARM) system is one of the significant evolutions of physics based model decision support systems in river operations. Its application will demonstrate this evolution and represents the future direction for river operations.

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ALL HANDS TO THE PUMP (PUMP-TURBINES, RENEWABLES)

BY EDUARD EGUSQUIZA



Eduard Egusquiza born in Barcelona is professor of Mechanical Engineering at the Universitat Politècnica Catalunya. He is Chair of the Committee of Hydraulic Machinery and Systems of IAHR and Director of the CDIF. His research interests are related to dynamic behavior of Hydraulic Machinery, Fluid-structure interaction and vibration based condition monitoring.

At present, new renewables (NRE) like wind, solar and marine energy are developing strongly and it is expected that in the near future they will have a larger share in total energy production. The strategic energy policy decided by the European Union is leading to a significant increase in the share of NRE which will produce a dramatic transition in the electric energy system.

The generation of energy via NRE has the disadvantage that it is dependant on atmospheric conditions, which means that energy can be generated independently at any moment if required or not by consumers.

For the stability of the electrical grid, supply and demand of energy has to be matched. The surplus of energy produced when consumption is low has to be stored and delivered again when consumption is high. Therefore, the future of NRE is tied directly to the future of energy storage.

At present, the only system to store huge amounts of energy with high efficiency is pumped storage (pump-turbine machines). In these plants the surplus of energy in the grid is used for pumping water to a higher reservoir

(pump operation). At peak hours, or in case of emergency, this water generates energy (turbine operation). And to guarantee this operation these machines have to be available at any time.

The capability of pump-turbines to store and to inject energy into the grid in a short time enables a widely distributed injection of solar and wind energy into the local transmission and distribution systems while preserving the grid stability.

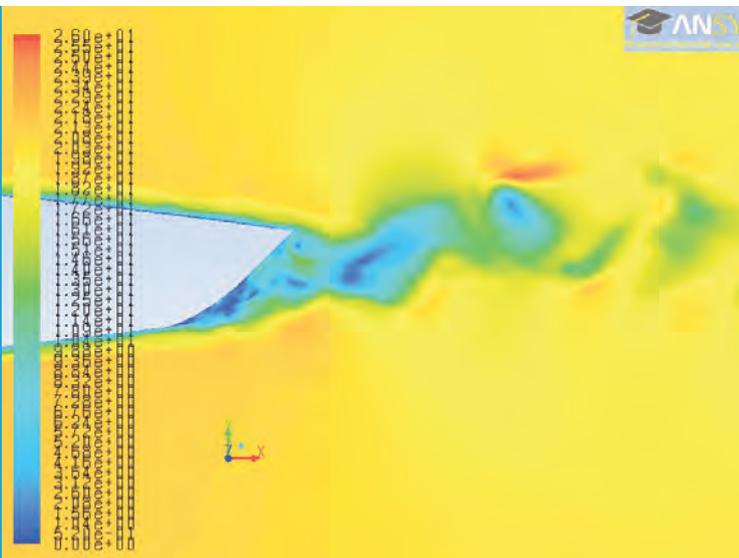
Therefore pump-turbines (and hydraulic turbines) are key technical components to achieve both load balancing and as well primary and secondary power grid control.

Pump-turbines (PT) are high performance machines that have to change operation from pump to turbine mode (reversing runner rotation and flow direction) in a short space of time. Due to their design characteristics and operating conditions, they generate large pressure pulsations and forces when in operation.

With the increasing production of NRE, as well as market regulations, new scenarios are appearing with:

- a large increase in the number of start and stop cycles. During transients between pump

LES unsteady simulation in the trailing edge of a hydrofoil (CDIF)



AND DYNAMICS)

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and turbine operating modes strong hydrodynamic instabilities like rotating stall can appear generating strong dynamic forces on the machine.

- a longer time of off-design operation at very low loads required by the market and by the grid authority. Deep part load or overload operation leads to complex flow inside the machine with secondary flows and cavitation, which are also sources of dynamic loading.
- the constant trend to increase the hydraulic power concentration in order to reduce cost. This leads to higher flow velocities and stronger pressure fluctuations.
- Faster start-up and coast-down for a better grid control.

The consequence is that dynamic loading, vibration levels and dynamic stresses are much increased. The turbine components as well as the whole hydraulic system including piping and PT structure has to resist all of these forces and keep stresses below fatigue limit, for a lifespan of several decades. On the other hand, instabilities and cavitation can impair the operation of the machine.

Due to these facts analysis of the dynamic behaviour is necessary. The challenge is to

calculate the hydraulic forces generated as well as the deformations, vibrations and stresses produced. The final objective is to determine the limits of operation and the residual life of the machine components.

Taking into account that the runner of a pump-turbine is a structure rotating inside a casing full of water at high pressure with very small clearances between the runner and the casing the dynamic response is very complex. Added mass and damping of water is affecting the dynamic very much.

To tackle these phenomena advanced three dimensional Computation Fluid Dynamic (CFD simulation) with better flow turbulence modelling is available. However advanced simulation methods are time consuming and sometimes are not applicable to industrial application in large machines.

Even with large computational power, some phenomena have to be investigated experimentally in models at reduced scale. In these test beds advanced equipment with high speed cameras, miniature embedded sensors, laser PIV and advanced acquisition systems are used. This advanced experimental research is

essential to understand some complex flow phenomena and also useful to validate computational models.

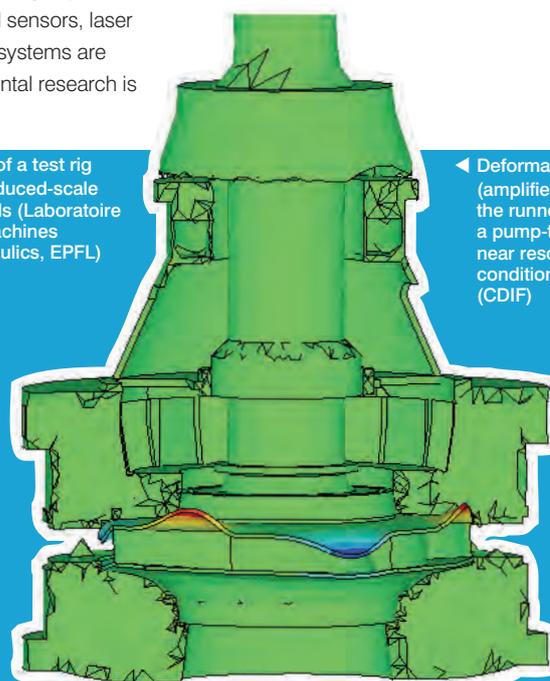
To analyse machine structure dynamics advanced Finite Element Models (FEM) which include the surrounding mass of water and complex boundaries are also available. The unsteady fluid flow and structure deformations can be calculated simultaneously (Fluid-structure interaction).

Because real machines have quite complicated boundary conditions, experiments are also necessary in actual machines. Moreover, the structural characteristics of a real machine cannot be reproduced completely in a laboratory model, so experimental research in prototypes is necessary.

Dynamics has also an important role in the upgrading of old power plants. Here a new runner with more power is installed inside the original casing generating new excitations that can produce damage in the machine.



◀ View of a test rig for reduced-scale models (Laboratoire de Machines Hydrauliques, EPFL)



◀ Deformations (amplified) in the runner of a pump-turbine near resonance conditions (CDIF)

STATEMENT REGARDING THE RECENT FLOODS IN GERMANY

HAS FLOOD PROTECTION FAILED IN JUNE 2013 IN GERMANY?

STATEMENT OF PROFESSORS HOLDING CHAIRS IN HYDRAULIC ENGINEERING AND ENGINEERING HYDROLOGY AT GERMAN UNIVERSITIES FROM 15 JUNE 2013.

The flood in June 2013 has caused enormous damages. As in 2002 and 2005, large areas have been flooded in Germany. The question for the reasons meets the core of our understanding about the interrelation between nature and humans.

Our opinion is the following:

Floods occur as a result of extreme weather conditions. The flood of 2013 was the result of extreme precipitation (200 mm within three days) which fell on extremely humid soils (highest soil moisture at the end of May 2013 in 50 years). For hundreds of years humans have been settling along large rivers. If we also want to use floodplains for settlements in the future, we cannot disclaim technical flood protection. Each flood is unique and demonstrates our natural limits in influencing such events. Humans can control such extreme floods only to a certain extent by technical measures and therefore they have to protect themselves against the consequences of floods. In many areas in Germany the dikes and flood protection systems, especially those which have been strengthened and newly built after the 2002 event, have fulfilled their protective functions.

Complete flood protection is not wise economically and technically often not possible either. Each increase of the degree of flood protection requires a social consensus as the comparison of the towns of Eilenburg and Grimma has demonstrated. In Eilenburg, an extended flood protection system was installed after the flood of the year 2002. In Grimma, a similar protection measure was refused by some parts of the local inhabitants. As a result, the city of Grimma was damaged in a similar way as in 2002, but flood damages in Eilenburg were very small compared to 2002. Therefore, individual responsibility of affected citizens is also required and must be complemented by national flood prevention. Society has to decide: How much flood protection is sufficient? Which risks are we willing to take in the future?

Technical flood protection must always be combined with flood prevention (What happens, if ...?). A failure of a protection system can never



be completely obviated. There is always a remaining risk whose minimization is also influenced by the effectiveness of defending the catastrophe. We have possibilities to estimate the consequences of the failure of technical systems. It is necessary to clarify in advance what is not allowed to occur at all (e.g. loss of lives or failure of critical infrastructure) and to concentrate the preventive flood protection on the core endangered areas. Such flood risk management requires the consolidation of flood prevention, technical flood protection and catastrophe defense.

Every avoided dike break increases the flood risk for the downstream areas. Therefore, large controllable flood polders and flood retention reservoirs have to be complemented by improved stable dikes. Moreover, the strengthening and building of new dikes in the affected areas require transnational flood protection concepts.

The sole demand for 'more space for rivers' does not consider the whole complexity of the problem, deflects from currently feasible solutions and cannot efficiently reduce the dangers of flooding in the coming decades. The deconstruction of dikes is a possible option for action as well as resettlements of residents of flood-prone areas, but only applicable if political willingness and social acceptance are present.

The many exceptional rules for allocation of building areas in flood-prone areas after the Water Resources Act are very questionable in that context.

In Germany we have the ability to improve flood protection. This requires expert knowledge to which we as researchers can and want to contribute. Many new developments have been implemented (e.g. new systems for dike control and safeguard, new large-scale planning tools for the development of transnational flood protection concepts for river basins which overcome the federal fragmentation of flood protection in Germany, new construction techniques for protecting buildings and infrastructure and flood-proof buildings). This requires awareness that flood protection is not a task recurring from time to time, but an ongoing service for the public in many areas in our country.

An improvement of the flood protection requires a social dialogue about handling of risks, openness in thinking, reality awareness and the willingness and power for changes. We offer our support for the implementation.

The following persons have written this statement:

Prof. Andreas Dittrich,
Technische Universität Braunschweig
Prof. Peter Fröhle,
Technische Universität Hamburg-Harburg
Prof. Kai-Uwe Graw,
Technische Universität Dresden
Prof. Uwe Grünewald,
Brandenburgisch University of Technology Cottbus
Prof. Uwe Haberlandt,
Leibniz Universität Hannover
Prof. Reinhard Hinkelmann,
Technische Universität Berlin
Prof. Jürgen Jensen,
Universität Siegen
Prof. Günter Meon,
Technische Universität Braunschweig
Prof. Heribert Nacken,
RWTH Aachen University
Prof. André Niemann,
Universität Duisburg-Essen
Prof. Peter Rutschmann,
Technische Universität München
Prof. Torsten Schlurmann,
Leibniz Universität Hannover
Prof. Andreas Schumann (Initiator),
Ruhr-Universität Bochum
Prof. Holger Schüttrumpf,
RWTH Aachen University
Prof. Jürgen Stamm,
Technische Universität Dresden
Prof. Stephan Theobald,
University of Kassel
Prof. Silke Wieprecht,
University of Stuttgart

9TH INTERNATIONAL SYMPOSIUM ON ECOHYDRAULICS

SEPTEMBER 17TH - 21ST, 2012 VIENNA, AUSTRIA

BY HELMUT MADER AND JULIA KRAML

The 9th International Symposium on Ecohydraulics was held in Vienna, Austria from September 17th - 21st, 2012. The Symposium was hosted in the "Water Campus" of the University of Natural Resources and Applied Life Sciences, BOKU.

International Symposia on Ecohydraulics have been arranged and hosted by members of the Ecohydraulics Committee of IAHR since 1994 in Trondheim, Quebec, Salt Lake City, Cape Town, Madrid, Christchurch, Conception and Seoul. The 9th International Symposium on Ecohydraulics was organized by the Department of Water, Atmosphere and Environment, Institute of Water Management, Hydrology and Hydraulic Engineering, BOKU, Vienna.

ISE 2012 has been an international and interdisciplinary platform for networking and information exchange and brought together 249 delegates, researchers and scientists from 33 countries affiliated with universities, planning offices, public authorities, and industry to debate the latest achievements in science and technology in the field of Ecohydraulics in 33 sessions of oral and 2 sessions of poster presentations. Out of 452 abstracts submitted, the International Scientific Committee finally has selected 200 oral presentations and 61 posters during the reviewing process to keep the scientific standard at a very high level. As the Symposium theme "Water is the origin of everything" - a quote from the Greek philosopher Thales of Miletus (624-546 A.D.) is still valid in our times and various human activities still affect the water cycle, and adverse environmental impacts have to be faced, the main objectives of the ISE 2012 focused on the central role of Ecohydraulics to analyze the inter-relationship between water and the environment, the assessment of human induced environmental impact and the development of water management strategies harmonizing economic as well as ecological requirements. Papers on the following topics: i) River restoration, ii) Aquatic ecology, iii) Habitat Modelling, iv) Minimum flow, v) Hydro peaking, vi) Aquatic continuum, vii) Fish migration, viii) Fish screening, ix) Sediment flow, x) Sediment interactions on habitat, xi) Flow regime alterations, xii)

Wetland and Estuary Restoration, xiii) Water management in wetlands and estuary, xiv) High technology on Ecohydraulics, xv) Effects of global climate change, xvi) Solute and Nutrient Transport have been presented at the symposium and have been included in the symposium proceedings.

The opening ceremony of the ISE 2012 was chaired by Prof. Helmut MADER, Conference Chairman, University of Natural Resources and Applied Life Sciences, BOKU with Opening Remarks and Welcome Messages by Prof. Georg Haberhauer, Vice Rector of the University of Natural Resources and Life Sciences and by Dr. Robert Fenz, Department Head, Section Water of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. The opening ceremony was completed by the keynote lecture of Dr. Birgit VOGEL entitled "Large River Basins and their Applied Management - Feasible or Not?" This introductory lecture for the Ecohydraulics 2012 conference focused on large river basins around the world, their basic natural features, key pressures/impacts and their basin-wide management. Following symposium days started with keynote lectures by Dr. Otto PIRKER from VERBUND Hydro Power, entitled "Re-establishing river continuity from an end users perspective", by Dr. Atle Harby, Director of the Center for Environmental Design of Renewable Energy at SINTEF, Norway, entitled "Eco-hydraulic research within Centre for Environmental Design of Renewable Energy" and by Prof. Claudio I. Meier

from the Department of Civil Engineering, Universidad de Concepción entitled "How Do Riparian Poplars and Willows really Establish along Gravel-Bed Rivers?".

The symposium offered 3 parallel sessions for oral presentations, 2 poster sessions and 3 Technical Tours visiting fish passes at Danube hydropower plants, the National Parks "Donau Auen" and "Neusiedler See – Seewinkel" and the Life Nature Project in world cultural heritage Wachau. Delegate Breakfasts & Daily Come Together, an Ice Breaker "Heuriger" with Wine Degustation and a Conference Banquet in the Vienna City Hall, Ballroom have been part and parcel of the social programme.

The full version of conference proceedings are published in the e-Book: 9th International Symposium on Ecohydraulics 2012 - Proceedings, Editors: Helmut Mader & Julia Kraml, ISBN: 978-3-200-02862-3 and can be downloaded from the Symposium webpage (www.ise2012.boku.ac.at). Selected papers will be published in special issues of LIMNOLOGICA - Ecology and Management of Inland Waters and JRBM - International Journal of River Basin Management.

The ISE 2012 was co-sponsored by the IAHR. The main support was provided by the University of Natural Resources and Applied Life Sciences, BOKU, the City of Vienna and the companies VERBUND Hydro Power AG, ANDRITZ Hydro, KIRCHDORFER Group and MABA as gold Sponsors of the ISE 2012.

"Water is the origin of everything"

Finally, 20 years after the first Symposium on Ecohydraulics was organized in Trondheim, it is a great pleasure for the Local Organizing Committee of the 10th Symposium on Ecohydraulics to welcome delegates back to Trondheim, Norway, 23rd – 27th June 2014 (www.cedren.no/ecohydraulics2014).

20TH EUROPEAN JUNIOR SCI SEWER SYSTEMS AND PROC

09 - 12 APRIL 2013, GRAZ, AUSTRIA

COLLECTIVE WORK OF THE WORKSHOP PARTICIPANTS

Introduction

The 20th European Junior Scientists Workshop on "Sewer Processes and Networks" was held in Graz, Austria, from 09 - 12 April 2013. Under the auspices of the International Water Association (IWA) and the International Association for Hydro-Environment Engineering and Research (IAHR), 18 international participants met on the Schöckl-mountain to present current research projects in the field of on-line monitoring, uncertainties in modeling and new pollutants. In a very friendly environment, the workshop provided an excellent opportunity for PhD-students and young scientists both from private and public institutions to tackle scientific problems together. The manifold topics illustrated the wide range of scientific issues related to urban drainage systems. These cover the catchment and its rainfall, the sewer system with the corresponding wastewater treatment plant (WWTP) and the receiving water. In addition, monitoring of processes and an appropriate data management still seem to be challenging, although significant steps have been achieved. The present article summarizes and concludes the workshop from the participants' perspective following the urban water cycle from the rainfall via the catchment, the sewer system, and the WWTP to the receiving water.

Catchment and rainfall

In urban areas, both point and non-point sources of pollutants contribute significantly to total emissions into water bodies. Hydraulic and pollutant emissions from sewers and WWTPs have significant impacts on the receiving water quality. Protecting the receiving water quality is one of the main goals of sewer systems and the *raison d'être* of WWTPs. Since the emission-immission approach was implemented into EU wastewater legislation (CEC, 2000), the attention of wastewater management needs to focus already upstream at the catchment scale to tackle preventively the sources and transport of pollutants.



View over Graz, Austria

Instead of the traditional approach of estimating only the daily pattern of wastewater flow and quality at a single outlet point, it is crucial to understand and identify the numerous water pathways in the whole catchment including wrong sewer connections and water infiltration into sewer systems from surface and groundwater. Regarding the sources and transport of pollutants, solids accumulated on roofs, streets, and parking lots during dry periods are one of the main contributions to pollution of surface runoff. Research is needed to develop and calibrate models to accurately estimate pollutant accumulation during dry periods and their wash off and transport by rainfall runoff. Micro-scale and local approaches are also required since even wash off, e.g. from roof gutters and valleys is a considerable source of heavy metals like zinc and lead.

As rainfall is a driving force of runoff and thus pollutant wash off, spatial and temporal information is of primary relevance to understand and manage pollutant fluxes. In many cases, the number and distribution of rain gauges is not adequate to come up with a representative spatial distribution. For this reason acquiring extra information has been the interest of several researchers. Besides the weather radars, telecommunication microwave links represent a source of rainfall information, which could aid in this regard.

Sewer and WWTP

After determining the rainfall runoff and pollutant fluxes from the catchment surface, it is necessary to better understand the processes occurring in the sewer. This is of paramount importance not only for design and operation purposes, but also to allow a grounded upgrading of sewer systems and WWTPs. Based on such knowledge, it will be possible to move towards an effective optimization of operational costs and to improve the wastewater's quality before it is discharged into the receiving waters.

During the workshop, different questions regarding sewers and WWTPs were presented, tackling the previous strategic issues. The effect of reducing potable water demand, by greywater reuse, on the transport of gross solids in sewer networks, the importance of understanding the sediment's layers constitution in order to predict the hydraulic capacity reduction, the prediction of the hydrogen sulfide gas (H₂S) rate emission under turbulent conditions to control odor, corrosion and safety are some of the topics of interest regarding sewer behavior. Online monitoring using turbidity probes for real time control of processes or measuring the hydrodynamic and separation processes to improve the design of primary settling tanks were topics more related to WWTPs.

One of the leading topics that these studies addressed are the changes in wastewater quantity and quality in different parts of sewer

SCIENTISTS WORKSHOP ON URBAN WATERS – A SUMMARY

systems. E.g., the reduction of water consumption decreases the volumes released into the sewer during dry weather periods but strongly increases the concentration of pollutants. Investigations are needed to understand the consequences of these new conditions for sewer systems, especially regarding sediment accumulation, H₂S production and sewer corrosion.

At the same time, policies for combined sewer overflow reduction lead to increased travel times and wastewater fluxes at the WWTP during wet weather periods. All those changes have to be anticipated in order to maintain or improve the water quality of the receiving water bodies. In this respect, real time control strategies on the integrated system represent an option, but subsequently require reliable online techniques focusing on water quality.

Receiving Water

Although short in time, wet weather flow peaks can significantly affect the receiving water quality with respect to (micro) pollutants. The estimation of pollutant emission from sewers and impacts on receiving waters during wet weather is difficult due to large variability of concentrations during and between events for most of the pollutant parameters. Apart from pollutants from the waste water system, the surface water also receives pollutants from various sources, like atmospheric deposition, drainage from agricultural areas and excretion of dogs and birds in urban areas. These may exceed the impact of emissions from the wastewater system. Since the relationships between pollutant loads and chemical and ecological effects are often non-linear, the singular effects of the emissions from various point and non-point sources into the receiving water cannot be assessed separately.

Long-term water quality dynamics (e.g. eutrophication) are difficult to describe with models. Especially when studying the ecological water quality, lots of other influencing factors may play a major role: geometry of the receiving water body, salinity, morphology, flow velocity, climate,

etc. High standard data collection is needed for a better understanding of water quality dynamics (chemical and ecological, short-term and long-term). For policy-making purposes, it is important to have insight in the potential positive effects of measures in wastewater systems or the catchment on the receiving water quality. Local approaches are necessary to take into account the specific characteristics of the waste water system, receiving water system and other influencing factors.

Monitoring and Data

More and more data on water quality and quantity from sewer systems, WWTPs and rivers are acquired in the course of research projects and applied urban water management. These data are especially used for system maintenance, operation and control, decision making or legislative purposes. The increasing amount of data available asks for reliable and harmonized methods to gather, store, preprocess and assess collected data. Best practices to ensure data quality has not yet been systematically implemented by operators and environmental authorities. This is mainly due to a lack of i) standardized protocols for monitoring operation (cleaning, operation frequency, metadata, etc.), ii) data validation, iii) calibration (most of research teams use different protocols), iv) well-trained staff and v) financial resources dedicated to maintenance. Urban drainage monitoring has been implemented in numerous international research projects, but there is still a lack of feedback and return on experience to support the development of new monitoring programs. Even under state-of-the-art monitoring, measurements are subject to uncertainties that need to be evaluated. Information about data quality and uncertainty is highly needed to describe the complexity of sewer systems, WWTPs and river processes or to calibrate accurate and robust models. Knowledge about uncertainties aims mainly to avoid wrong data analysis or interpretation errors during decision making processes. High-quality data, a prerequisite of clear and convincing results and conclusions, is also the

condition to ensure the successful transfer of experience between research teams and stakeholders.

Urban drainage monitoring focuses on a wide panel of parameters (pollutant, flow, rainfall, etc.) using different technologies (e.g., sampling or on-line monitoring). Research is still needed to enhance the description of not well understood phenomena (e.g., in-sewer sedimentation, pollutant accumulation and erosion) or to reduce current high monitoring costs (e.g., trace pollutants, development of cheap sensors, software sensors, and use of data available from other services or companies). On the other hand since a lot of technologies are already available, more studies are needed to compare and evaluate existing products.

Conclusion

The 20th European Junior Scientists Workshop was an excellent opportunity for PhD-students and young scientists to address prospective challenges regarding the urban water cycle and its characterization. It clearly demonstrated the diversity of ongoing research on sewer systems and processes, especially on modeling and monitoring of pollutants in urban areas. On the other hand it also showed the interdependencies within the urban water cycle and stressed the need of complex approaches both in waste water management (operation) and research. According to the invitation of the organizers, the workshop offered a friendly and inspiring environment to bring young scientists together. Numerous fruitful discussions, a lively exchange of ideas and hopefully a starting point for future research collaborations confirmed this. The participants would like to thank the organizers again for the very successful event.

More information and the participants released abstracts and/or held presentations can be found on the workshop's website: <http://www.ejsw-2013.tugraz.at>

References

CEC. (2000). Directive 2000/60/EC establishing a framework for Community action in the field of water policy. Official Journal of the Europ

James Sutherland has been promoted Technical Director at HR Wallingford



He is on the Advisory Board for Hydrolink and is member of Coastal and Maritime Hydraulics Committee.

James Sutherland is a Technical Director in the Coasts and Estuaries Group at HR Wallingford, as well as an internationally known specialist in coastal & marine processes with 24 years' experience of working and publishing on nearshore hydro-

dynamics, sediment transport (including scour around coastal structures and coastal erosion) beach management and wave forces on maritime structures. He has worked on projects in over 20 countries in Europe, the Middle East, Asia-Pacific and Africa.

Marcelo H. Garcia has been elected 2013 Distinguished Member of ACSE



Thanks foreminent research on fluvial and coastal sediment transport and environmental fluid mechanics, application of this understanding to a broad range of applied problems, engineering education and for leading the ASCE Sedimentation Manual 110 to publication.

Marcelo García is former JHR Editor and active Member of IAHR.

Dr. Mahad Said Bawaain, has been appointed Director of the Centre for Environmental Research at Sultan Qaboos University in Oman



CESAR came into existence in 2000 in order to promote and coordinate environmental studies and research at Sultan Qaboos University. Its vision is to help various agencies of the government in their efforts to protect and maintain the nation's pristine environmental resources through planned initiatives and research.

Mahad Said Bawaain is Chair of the IAHR-MENA (Middle East North Africa) Collaboration Committee. For more information on the Committee visit IAHR website under About IAHR/ Regional Divisions.

For information about CESAR please visit <http://www.squ.edu.om/center-environment/tabid/9153/Default.aspx>

New Student Chapter at University of Central Florida



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PEOPLE & PLACES

Dr. Michaela T Bray, JRBM Acting Editor in Chief from July 2013



Dr. Bray is a PhD graduate of the University of Bristol and now a Lecturer at Cardiff University in the UK. Michaela is a Civil Engineer with both research and industry experience, and is best known for her research on Numerical Weather Prediction and flood forecasting. She will be acting as Editor in Chief from July 2013 to January 2104 when Dr. Giuliano Di Baldassarre of UNESCO-IHE in Delft will take

over as JRBM Editor in Chief. Michaela is replacing Prof. Paul Bates who has been the Editor for 10 years and has recently been promoted to Head of the School of Geographical Sciences of the University of Bristol, UK.

New institute member Water Resources University, Hanoi, Vietnam

WRU was established in 1959. Currently WRU is a premier university in VN, in the field of Hydraulic- Hydro-power and Water Resources for industry, agriculture and socio-economics and rural development.

For more information visit the website <http://en.wru.edu.vn/>

Dr. Motoi Kawanishi has retired

He has been Senior Associate Vice President, Director, Nuclear Fuel Cycle Backend Research Center, Civil Engineering Research Laboratory Central Research Institute of Electric Power Industry (CRIEPI) <http://criepi.denken.or.jp>

2013 Lifetime Members

This category was established to recognize long term dedication to retired members with 30 year membership and a minimum age of 60.

- Prof. Bela Petry, Consultant, Germany
- Dr. Amruthur.S. Ramamurthy, Concordia University, Canada
- Dr. Vijay Singh, Texas A&M University, United States of America
- Dr. George W. Annandale, Golder Associates Inc., United States of America
- Prof. Robert Keller, R. J. Keller & Associates, Australia
- Dr. Graeme M. Smart, New Zealand National Institute of Water & Atmospheric Research (NIWA), New Zealand
- Prof. Julián Aguirre Pe, Universidad de los Andes, Escuela de Ingeniería Civil, Venezuela

A sad moment

Prof. Umesh Chandra Kothiyari (1959-2012)

Prof. Kothiyari earned his Master's degree in civil engineering in 1984 from the University of Roorkee, Roorkee IN (now called IIT Roorkee) where he worked until his premature death.

To read a full obituary go to www.iahr.org under About IAHR/obituaries



Booking your flight to IAHR World Congress? Don't forget it's cheaper with Qatar Airways!

IAHR has signed an Agreement with Qatar Airways as official carrier which offers large discounts Qatar's already competitive air fares to delegates attending future IAHR-sponsored conferences. The first conference to benefit from this agreement is the World Congress in Chengdu - where Qatar Airways has just started a thrice weekly service. The exclusive fares apply on fares to Beijing, Chongqing, Chengdu, Guangzhou, & Shanghai from 32 European cities. If you are now booking your flight to attend the Congress in September, visit this website and use the special promo code: CTUIAHR13

The next events to benefit on this discount will be HYDRO2013 conference in India (Dec 2013) and 7th International Symposium on Environmental Hydraulics in Singapore (Jan 2014). More information and promo codes on www.iahr.org

Roll of Honours

- Dr. Zhigang Zuo, China introduced by Prof. Shuhong Liu, China
- Prof. Dr. Viet Nguyen Trung, Vietnam introduced by Prof. Hitoshi Tanaka, Japan
- Ing. Carlos Manuel Iparraguirre Ortiz, Peru introduced by Mr. Jose N. de Pierola C., Peru
- Dr. Adam Pamudji Rahardjo, Indonesia introduced by Prof. Djoko Legono, Indonesia
- Dr. Gabriel Usera, Uruguay introduced by Dr. Rafael Terra, Uruguay
- Ing. Quintilia López López, Spain introduced by A.E. Mynett, The Netherlands
- Prof. José Montejo Marcos, Spain introduced by Prof. Luis Balairón Pérez, Spain



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