INTERNATIONAL ASSOCIATION FOR COASTAL RESERVOIR RESEARCH

School of Civil, Mining and Environmental Engineering
University of Wollongong, Northfields Avenue, NSW 2522, Australia
http://iacrr.org | iacrr.org@gmail.com | Ph: +61-2-42213070

# IACRR CONNECT

Volume 5 |Issue 1|2021

## Message from the PRESIDENT of IACRR

Dear IACRR members, Colleagues and Friends,

It is a great pleasure to present the post Pandemic edition of the IACRR Connect – Vol 5. We have experienced a totally new overall environment during the time and learnt big lessons for our life and overall for future. I see this crisis in a positive way for our futuristic planning processes and to incorporate new ways to tackle such disasters in future. Due to the worldwide restrictions for COVID19, we could not hold one of the most important event of IACRR, 1st International Conference in Hohai University. We have postponed the event to 9th – 12th Nov, 2022. But slowly we cope with the new normal and hosted so many webinars & e-conferences. One of the major event was the virtual launch of AIWC, signing of MOU by a consortium of 9 Australian and 15 Indian Universities and Institutes to promote cooperation and collaboration in water research, education, training, and capacity building. Another important event organized by IACRR was the "International Workshop on Coastal Reservoirs" in association with the Ministry of National Development Planning and Indonesia Engineers Institute.

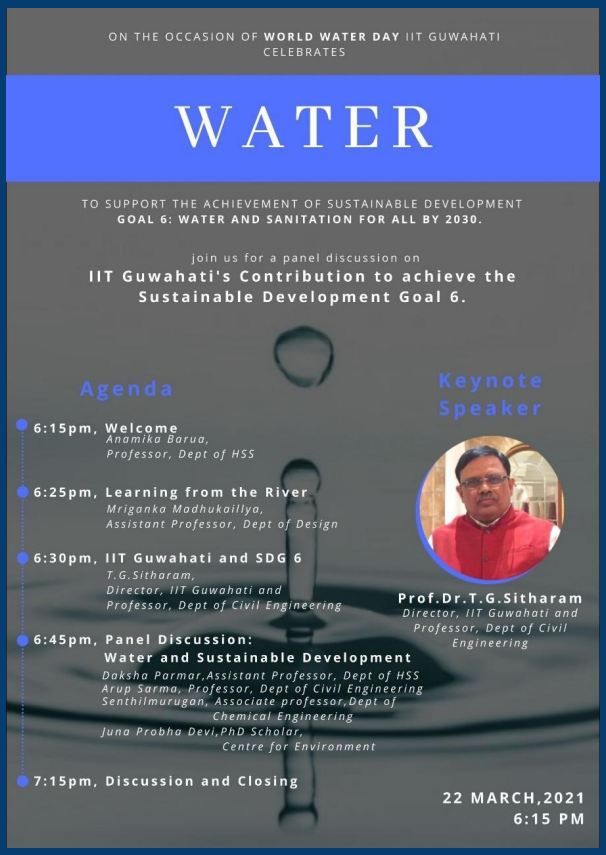
**Prof. Thallak G Sitharam**
President, IACRR

As premier association of International Association for Coastal Reservoir (IACRR), we have to go ahead with our partners and work hard to fulfil the Sustainable Development Goals for the world by 2030. During the Pandemic crisis, it has been observed that availability of fresh water to the world community was a major concern. Usages of water has also been increased with the UN guidelines for maintaining personal cleanliness and hygiene. It is the high time to implement policy for the reuse of fresh water in society and we have to work with the Government authorities for formulating the suitable policies and as a technical society we have to work with the cities/Govt. institutions to develop coastal reservoirs in coastal regions.

Hon'ble PM of India in association with the ministry of Jal Shakti launched the "Catch the Rain" movement during the World Water Day. Rain water is the major source of fresh water and preserving that in coastal

areas using CR's can reduce the water shortage to some extent.

On the occasion of World Water Day, IIT Guwahati celebrates, WATER to support the achievement of sustainable development




GOAL 6: Water and Sanitation for all by 2030 on March 22nd, 2021. Several dignitaries, professors of IIT Guwahati and research students participated in the panel discussion on IIT Guwahati's contribution to achieve the SDG6.

I welcome you all to contribute to the newsletter IACRR Connect. I hope you will like the contents of this issue and I thank all the contributors. Happy reading IACRR Connect.

Regards,

(**Prof. T. G. Sitharam**)
Ph.D(Waterloo, Canada), FASCE, FICE(UK), D.Ge., FISET, FIGS, FISES, FIE(India),P.Eng.,C.Eng
PRESIDENT, International Association for Coastal Reservoir Research (IACRR), AUSTRALIA and Director, IIT Guwahati, INDIA

## Call for IACRR Corporate Membership

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- **Project management and investment**
- **Integral development of water, land and human resources**
- **Education and public relationship**
- **Water-food-energy nexus and fish farming**

**IACRR is the world-leading association in floodwater development from the sea using coastal reservoir from research to construction and management.**

IACRR is a worldwide independent organisation of engineers, water specialists and water lovers working in fields related to floodwater development from the sea in order to quench the global water thirst. We are going to help construct coastal reservoirs using our knowledge from hydro-environmental science and our experience in practical application. Activities range from river and coastal hydraulics, fluid mechanics, to water resources development and ecohydraulics, through to construction and management. IACRR stimulates and promotes both research and application of Coastal Reservoir technology, and by so doing strives to contribute to sustainable development, the optimization of world water/land/human resources management and development. Our final goal is to create happy life for coastal residence. IACRR accomplishes its goals through a wide variety of member activities including: working groups, research agenda, congresses, specialty conferences, workshops and short courses; Journals, Monographs and Proceedings; by involvement in international programmes such as the EV, UNESCO, WMO, IDNDR, ICSU; and by co-operation with other water-related (inter)national organisations.

**Fee structure: IACRR Institute Membership is US$1000/year**
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## A Report on

# International Workshop on Coastal Reservoir: Water Availability, Coastal Security, And Sustainability Organized by The Ministry of National Development Planning/ Bappenas of the Republic of Indonesia in Collaboration with The Institution of Engineers Indonesia (PII) and International Association for Coastal Reservoir Research (IACRR)

Ir. Purba Robert Mangapul Sianipar, MSCE, MSEM, Ph.D., IPM, ASEAN Eng.

The Ministry of National Development Planning/ Bappenas of the Republic of Indonesia, in collaboration with the Institution of Engineers Indonesia (PII), and International Association For Coastal Reservoir Research (IACRR) have hosted an International Workshop on Coastal Reservoir on 26th to 27th October 2020. Development of coastal reservoirs as a promising solution to overcome the problems of water shortage and floods in Indonesia may be inevitable. Indonesia is water rich country but some areas of the country experience water scarcity, especially Java Island. Java island is home to nearly 60 percent of the 273 million of Indonesia population. Jakarta, the Capital City of Indonesia as well as the economic center of the Country, which is located in Java Island, has only six percent of the country's water that can be used and consumed. A city with more than 12 million population, Jakarta has experienced a deficiency in water supply from its own water resources. Today, Jakarta receives additional supply of raw water from its neighboring provinces, namely from West Java Province and Banten Province. Even then, the supply of water is not quite sufficient to meet the need of the City.

In addition, existing raw water sources are increasingly polluted due to domestic, industrial, and agricultural wastes. This condition makes the availability of raw water is not guaranteed in terms of quantity and quality. Furthermore, many large cities in the northern part of Java such as Jakarta, Semarang, Cirebon, Demak, and Pekalongan are experiencing shortage of water couple with land subsidence with the rate of subsidence is varying from 1 cm/year to 15 cm/year. The land subsidence is mostly due to an excessive groundwater abstraction. In addition, the phenomena of coastal floods along Northern Coast of Java Island are becoming more and more frequent and severe due to land subsidence and sea level rise. Hence, it becomes essential and urgent to have more water storage to meet the demand for water supply, and at the same time to control and reduce the land subsidence.

Another pressing issue is the changes of land use and land transformation. The large amount of land that functions as water storage (lake, pond, reservoir) has been converted into residential estates or industrial and commercial areas, resulting in a decrease of water storage capacity.

In Indonesia, the provision of water storage is currently being intensively carried out through the construction of new dams, reservoirs, and ponds. Sixty-three percent of total storage nationwide is concentrated in Java (World Bank Report, 2020), but there are some strategic issues in dams' operation and maintenance. These are related to the age of dams, inadequate funding for operation and maintenance, and incomplete dam safety instruments that comply with safety standards. In addition, the capacity of the existing reservoir has decreased due to sedimentation with average reduction until 2019 has reached 19% nationwide, and in Java it has reached 31%. In addition, the construction of water storage infrastructure on land is limited by land availability. For Java Island, it is very difficult to find adequate space on land for location of new dams and reservoirs since most of the land has been occupied for human and economic activities.

This International Workshop was held to share knowledge, insight, and experiences related to potentials and challenges in the development and construction of coastal reservoirs. **The workshop invited water resources planners, researchers, academics, engineers, and scientists across the world to discuss feasibility of coastal reservoirs in securing water supplies and in functioning as flood control.** The keynote speaker who attended this workshop comes from various expertise and institutions. They presented various topics related

Kementerian PPN/ Bappenas

PERSATUAN INSINYUR INDONESIA PII

IACRR

## International Workshop

# Coastal Reservoir

### Water Availability , Coastal Security, and Sustainability

### October 26 - 27, 2020

**Opening Speech**

**Dr. (H.C.) Suharso Monoarfa***
the Minister of National Development Planning/Bappenas
*in confirmation

**Welcoming Speech**

**Dr. Ir. Heru Dewanto**
President of The Institution of Engineers Indonesia

**Keynote Speech**

**Deputy for Infrastructure Bappenas, Indonesia**

**Speakers**

**Abdul M. S. I., M.Eng.**
Director Bappenas, Indonesia

**Prof. T. G. Sitharam**
President of IACRR

**Prof. R. A. Falconer**
Vice President of IACRR

**Prof. H. Savenije**
TU Delft, Netherlands

**Prof. Joseph Lee**
Hong Kong UST, Hong Kong

**Prof. Chu Jian**
NTU Singapore

**Prof. Shuqing Yang**
Univ. of Wollongong, Australia

**Prof. Sivakumar M.**
Univ. of Wollongong, Australia

**Ir. Lim Sin Poh**
IACRR Malaysia, Malaysia

**Young Joo Chye***
Director at PUB Singapore
*in confirmation

**Batam Free Trade Zone Authority,Indonesia***
*in confirmation

**Maryadi Utama, MSi.***
Head of BWS Bali Penida, Indonesia
*in confirmation

**Responders**

**Prof. Indratmo Soekarno**
ITB, Indonesia

**Prof. Nur Yuwono**
UGM, Indonesia

**Andojo Wurjanto, Ph.D.**
ITB, Indonesia

**Prof. Jan Sopaheluwakan**
UI and LIPI, Indonesia

**Streaming at:**

**Zoom:**
**1000 Participants Only**

**YouTube:**
**bit.ly/NJICD**

**Registration at:**
**bit.ly/IWCoastalReservoir**

Background photo by Michael Olsen

to coastal reservoir development and construction. The keynote speakers who have participated in this significant workshop are:

1. Abdul Malik Sadat Idris, S.T., M.Eng (Director for Water Resources and Irrigation, the Ministry of National Development Planning of the Republic of Indonesia) . Topic: "North Java Integrated Coastal Development"

2. Prof. Joseph Lee (President of the International Association for Hydro-Environment Engineering and Research (IAHR), Hong Kong University of Science and Technology). Topic: "Water Engineering and The Ecological Civilization"

3. Prof. Thallak G. Sitharam (President of International Association for Coastal Reservoir Research (IACRR), Director of India Institute of Technology Guwahati) Topic: "Coastal Reservoir in Earthquake-prone Regions"

4. Professor Roger A. Falconer (Past President of IAHR, Current Vice-president of IACRR). Topic: "Coastal Reservoirs: Hydro-environmental Aspects for Urban Regeneration and Energy Supply"

5. Prof. Hubert H.G. Savenije (Past president of International Association of Hydrological Science, Current Vice President of IACRR, Technology Univ. of Delft, the Netherlands). Topic: "Changing Perspectives on Coastal Reservoirs in The Netherlands"

6.Prof. Chu Jian (Chair of CEE School, NTU - Singapore). Topic: "A Geotechnical Perspective of Coastal Reservoir and Seawall Construction"

7. Prof. Sivakumar (Assoc. Professor at Univ. of Wollongong, Australia). Topic: "Water Quality Challenges for Coastal Reservoir Development"

8. Prof. Shuqing Yang (Assoc. Professor at Univ. of Wollongong, Australia). Topic: "History of coastal reservoir technology and its potential applications in Indonesia"

9. Ir. Lim Sin Poh (Global Water Consultant)Topic: "Coastal Reservoir as Innovation Solutions to UN Sustainable Development Goals (SDG6)"

10. Dr. Ir. Asnor Muizan Bin Ishak (Senior Principal Assistant Director at Department of Irrigation and Drainage, Malaysia). Topic: "An Introduction of Water Balance Management System (NAWABS)"

11. Mr. Young Joo Chye (PUB Singapore). Topic: "A Success Story of Marina Barrage in Providing Water Supply and Flood Control in Singapore"

12. Hadjad Widagdo, S.Hut, MM (Batam Industrial Free Zone Authority (BP Batam)). Topic: "Challenges in the Development of Coastal Reservoir in Batam (Duriangkang Reservoir, Tembesi Reservoir, and Rempang Resevoir)".

13. Maryadi Utama, M.Sc (Head of Bali Penida River Basin Organization). Topic: "Challenges in the Management of Nusa Dua Coastal Reservoir as a raw water provider in the Denpasar, Benoa, and Nusa Dua (Bali) areas".

The lectures given by all distinguished keynote speakers during the workshop are addressing various aspects of coastal reservoir as well as the related hydraulic mechanisms involved. The keynote speakers highlighted important issues in their lectures as the following:

1. **Coastal reservoir development is considered as an integrated solution to solve the flooding problem and water shortage in Java**. It is also expected that in addition to store fresh water, the development of coastal reservoir can create another benefit such as: (a) additional space for regional development without sacrificing productive land; (b) opportunity to increase connectivity by developing offshore road or railway integrated with sea dike; (c) additional land for residential, business, and commercial.

2. **Water engineering and technology is a major driver of economic growth**. Hongkong has developed innovative urban stormwater management, smart environment management and smart urban water supply system. These technologies are used to reduce stormwater runoff, detect defect on piped water distribution system, support food security, and predict algal bloom risk.

3. China's experience shows that inter-basin water diversion should consider coastal reservoirs. For very large river basin, wetland pre-treatment may be needed.

4. **2nd generation of coastal reservoir is cost efective, environmentally friendly, socially acceptable, and provides high quality water.**

5. **Coastal reservoirs offer opportunities to: (a) address the water-food-energy nexus, (b) provide crucial resource of freshwater storage adjacent to major coastal cities; (c) deliver urban regeneration; (d) provide source for predictable renewable energy (tidal and/or hydro), and for flood protection**

6. Development of costal reservoirs needs comprehensive study based on adequate primary data, simulation modelling of the plan, possibility of installing minimal hydro power, and environmental impact of the plan

7. Singapore's experience shows that to ensure good water quality of the coastal reservoir, it is important to: (a) implement strict regulation, surveillance, and enforcement against water pollution; and (b) implement an integrated catchment water quality management to tackle pollutant sources in urban area and in catchment area

8. The design for coastal reservoir needs to consider the challenges of sea level rise and its environmental effect.

9. A coastal reservoir should integrate multiple functions so the construction process and the use of space and resources can be optimized.

10. Several innovative seawall construction methods, based on the field conditions, are available which could be selected for the construction of coastal reservoir.

11. A suitable and properly designed coastal reservoir has the ability to alleviate multiple problems, including water supply, flood protection, and river environmental flows.

12. Water contaminants loads are related to the land use of the catchment area and, hence, unless integrated catchment area management practices are not enforced, potential deterioration of water quality downstream is inevitable.

13. All 1st generation coastal reservoirs are showing expected undesired water quality problems and, hence, should not be avoided, both for water quality and other environmental reasons.

14. Hence, the 2nd generation coastal reservoir design must undertake long term integrated modelling of both water quality of river and reservoir system, and should consider the environmental and social aspects associated of such major infrastructure development near the coast.

15. Based on the pointers above, suggestion given for the plan of developing coastal reservoir in Jakarta Bay, Indonesia, are as follows:

- Monitor incoming water quality from the river, the good quality water is stored in a clean water reservoir for water supply, the worst quality water is stored in the wastewater reservoir for further treatment. As a result, there are two compartments in the coastal reservoir.
- The sizes of these two compartments are relatively small so that they could be managed efficiently. Big or oversized water body generally has water quality problem due to long detention time.
- Mitigate flood disasters by stormwater. In flood events, most of the river water is allowed to flow directly to the sea, not to the coastal reservoir.

16. **Coastal reservoir is a better option since Indonesia is located in an active earthquake zone, since coastal reservoir will avoid disaster if fails as compared to an upstream dam/reservoir.**

17. The perspectives on coastal systems, reservoir and delta plan, in the Netherlands are continuously changing to adapt with the environment and future problems.

In each session, after the keynote speakers presenting their lecture materials, there is a responder that clarifies or gives opinion to support or have different perspective on the lecture materials. These responders, one for each of the 4 sessions, are experts in water resources fields and are coming from well-known universities in Indonesia. These four faculty members are from Bandung Institute of Technology, University of Indonesia, and Gadjah Mada University are invited to give respond or opinion on the keynote lectures. As a matter of fact, they are also members of the newly established Indonesian Chapter of International Association for Coastal Reservoir Research. Their responds and opinions could be summed up as follows:

1. Coastal reservoir is necessary and essential to be developed to solve the water shortage and flooding problems on the North Coast of Java.
2. To gain acceptance and support from the stakeholders, the objective and operational of coastal reservoir development should be clear and manageable.
3. A coastal reservoir should not collect polluted water.
4. Dike structure for coastal Reservoirs on the North Coast of Java require high durable structure/materials, do not require replacement in its service life, and the crest can be raised over time.
5. The successful of marina barrage in providing water supply and flood control in Singapore can be taken as a reference for the development of coastal reservoir on the North Coast of Java.
6. Coastal reservoir might solve the water resource provision but land subsidence remain challenging. It is suggested that the water should be kept as long as and as much as possible on land. Another solution is by an ecological approach by rewetting the wetland and creating more blue space (polder, retention pond, city regeneration).
7. Development of Coastal Reservoir on Cisadane river mouth should consider future urban regeneration and ecosystem restoration.

**More than one thousand participants attended this resourceful workshop through zoom webinar and YouTube.** These participants come from all over Indonesia, Southeast Asian Countries (Singapore, Malaysia, Thailand, Philippine, and Vietnam), India, the Netherland, Australia, USA, and other countries in Asia. This shows that the topic of the workshop on coastal reservoir has drawn significant attention globally and therefore it received very good response widely. After each of the lecture from keynote speaker there was question and answer session, so that all participants were able to explore deeper while still on the topic given. The participants raised the following questions:

1. How to control coastal reservoir sedimentation?
2. What are the most critical criteria for assessing the feasibility of coastal reservoir?
3. How to control nutrient supply from river?
4. How to predict algal blooms occurrence in coastal reservoir?
5. Between engineering, social, legal, and environmental aspects, which one is the most challenging in developing a coastal reservoir?
6. Between underground reservoir, onshore reservoir, and coastal reservoir, which one is the most practical and economical choice?
7. How to deal with water quality and geotechnology aspects in developing coastal reservoir?
8. Based on Sihwa reservoir's experience, is it difficult, or even impossible, to processing polluted water to clean water?
9. What is the strategy to get stakeholders support for the coastal reservoir plan and how long does it take to change the mindset of the people who live in the Marina Bay catchment area to participate in ensuring a good quality of reservoir water?
10. Between reverse osmosis and coastal reservoir, which one gives more benefits in producing clean water?
11. How can PUB (Public Utility Board) or the Government of Singapore keep the catchment area of coastal reservoir remain free from waste and contamination? In case of the catchment area of reservoir occupied by people, how to control their activity to ensure good environmental condition?
12. How to increase durability of geosynthetic materials in seawall construction?
13. Considering the complexity of the development of sewerage system in Jakarta, is it more efficient to manage wastewater in downstream close to coastal reservoir rather than manage it at its upstream source?
14. Which one is better, treating the river water before entering the coastal reservoir or treating the reservoir water before it gets distributed?
15. Is there any negative impact to the environment and surrounding areas due to changes in the coastline after a coastal reservoir has been constructed?
16. If the main purpose of coastal reservoir development is to store raw water, is it appropriate to build a coastal reservoir on the Northern coast of Jakarta since rivers in Jakarta are heavily polluted?

From the question-and-answer sessions, it is noted that water quality, environmental impact, and reservoir sustainability are of foremost concern. Hence, any plan to build coastal reservoir must address in details these important factors.

**Concluding Remarks**

The enthusiastic response from international communities to the International Workshop on Coastal Reservoir shows that the need to have more space to store fresh water will be increasing. When space on land to build reservoirs is no longer available then the best option is to build offshore reservoir or coastal reservoir. **It is a paradigm shift from upstream/on land reservoir to downstream/coastal reservoirs to meet the challenge of SDG6.**

For Indonesia, where 60% of its 272 million population lives in Java Island, the need for fresh water is increasing. In fact, the carrying capacity of water availability on the island of Java has been exceeded. The Java Island's water balance is currently in deficit. Therefore, **the development of a coastal reservoir is the right choice to overcome the water crisis on the island of Java**. The recommendation of coastal reservoir as the solution has been endorsed by United Nations World Water Development Report 2020. It states that "an emerging solution to the water supply problems of coastal megacities is the creation and use of coastal reservoirs, which provide water storage facilities at or near the mouth of rivers."

The Organizing Committee of the International Workshop on Coastal Reservoir acknowledged significant contribution of Ministry of National Development Planning of the Republic of Indonesia, Institution of Engineers Indonesia, and the the IACRR to the execution and success of the workshop. As the result, it is expected that the coastal reservoir concept would become widely known and accepted in Indonesia. It is now the duty of the Indonesian Chapter of IACRR to further promote the coastal reservoir concept for further research and implementation in Indonesia.

# 'Flushing time' scales in a Coastal Reservoir

Ajit Godbole , agodbole@uow.edu.au

*School of Mechanical, Materials, Mechatronic and Biomedical Engineering,*

*Faculty of Engineering, University of Wollongong, NSW 2522, Australia*

**Background and Motivation:** Urban centres continue to grow worldwide at an ever-increasing rate. The problem of ensuring an adequate supply of clean water to the burgeoning populations in these centres is becoming more and more acute. Ensuring the availability of clean water and sanitation has been adopted as one of the Sustainable Development Goals (SDGs) by the United Nations.

Why has the problem become so acute? The generally accepted view is that there is shortage of clean water. This view has been challenged by pointing out that the real problem is not one of not inadequate *supply*, but one of inadequate *storage*.

**Possible Remedy:** The 'coastal reservoir' concept has been proposed relatively recently as a potential remedy to the problem of water shortage in large cities and metropoles. The concept involves capturing flood water that would otherwise run off into the sea, and storing it in *offshore* reservoirs near estuaries. In an estuary, large volumes of river water drain into the sea during floods and periods of high rainfall.

One of the tools of estuarine management is the 'flushing time' concept. This is used to determine how much of a potentially harmful substance an estuary can tolerate before its ecosystem is adversely affected to a significant degree. In the present study, the concept of 'flushing time' is used in a different sense. When applied to flow in a coastal reservoir, it means the time required for naturally flushing out saline water from a given volume, and replacing it with fresh water. In the following paragraphs, it is suggested that this concept can be used to arrive at an optimised design of a coastal reservoir, using the techniques of Computational Fluid Dynamics (CFD) as a design tool.

**Two-Dimensional CFD Simulations:** The simplest geometry of the computational domain is a two-dimensional slice of the flow field, shown in Figure 1.

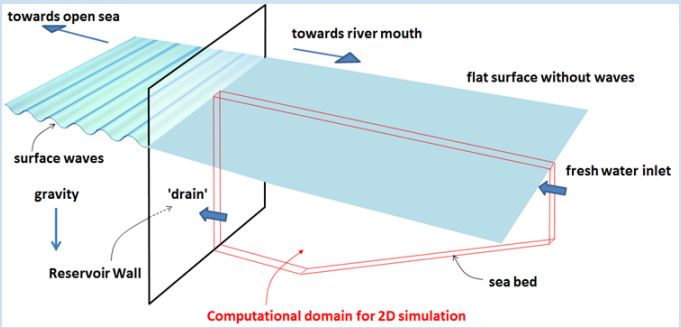



Figure 1. Schematic of 2D computational domain

The parameters that are likely to determine the flow patterns in a coastal reservoir are:

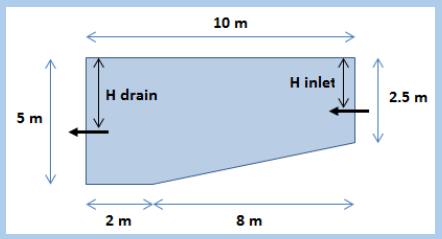
Geometric parameters:

1. total volume;
2. area of fresh water inlet;
3. area of drain (outlet) in reservoir wall;
4. location of fresh water inlet (e.g. depth below the free surface); and
5. location of the drain (e.g. depth below the free surface).

Flow parameter:

1. Velocity of fresh water at inlet.

Different variations of the basic configuration in Figure 2 were analysed. At this preliminary stage, only the locations of the fresh water inlet and the drain were varied. Table 1 summarizes the differences in the configurations.




| | H inlet (m) | H drain (m) |
|---|---|---|
| Configuration 1 | 0.61 | 4.35 |
| Configuration 2 | 1.00 | 4.00 |
| Configuration 3 | 1.00 | 3.00 |
| Configuration 4 | 1.75 | 3.00 |

Table 1. 2D simulation configurations

As the transient calculation proceeded, the 'flushing efficiency' was monitored in terms of the average value of fresh water volume fraction. Figure 5 compares the evolution in the value of fresh water concentration in the reservoir with time for the different configurations, in terms of the value of average volume fraction of fresh water over a period of 100 sec.

Also shown in Figure 5 is the 'ideal' time needed

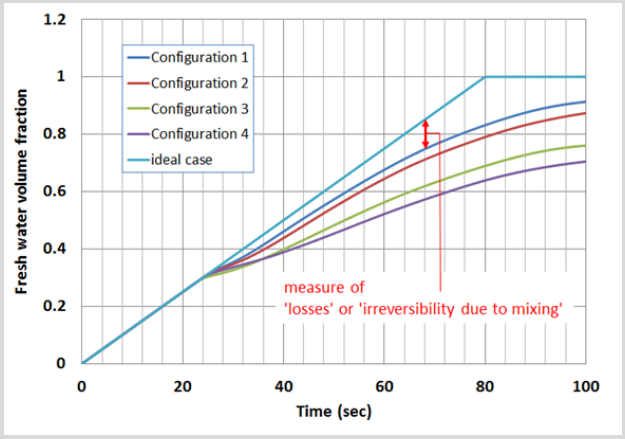



Figure 5 'Flushing efficiency' for the four configurations tested

for fresh water to completely fill the entire volume of the coastal reservoir (fresh water volume fraction = 1).

Figure 6 shows a detail of Figure 5 during the first 30 seconds, along with instantaneous snapshots of the simulated mixing process over the first 25 seconds.

During the initial period, all the graphs overlap. Subsequently, the graphs deviate from the ideal trend, the deviation being greater the farther up the drain is from the sea bed. The most obvious result that stands out is that **the 'drain' must be located as close to the sea bed as possible (large value of '$H_{drain}$') for the flushing to take place efficiently in the shortest time. This is due to the tendency of the incoming fresh water to float on top of the heavier sea water, even as the fresh water displaces (flushes out) the sea water.**

These preliminary two-dimensional studies have been extended to three dimensions, and can be potentially carried out on realistic estuarine scenarios.

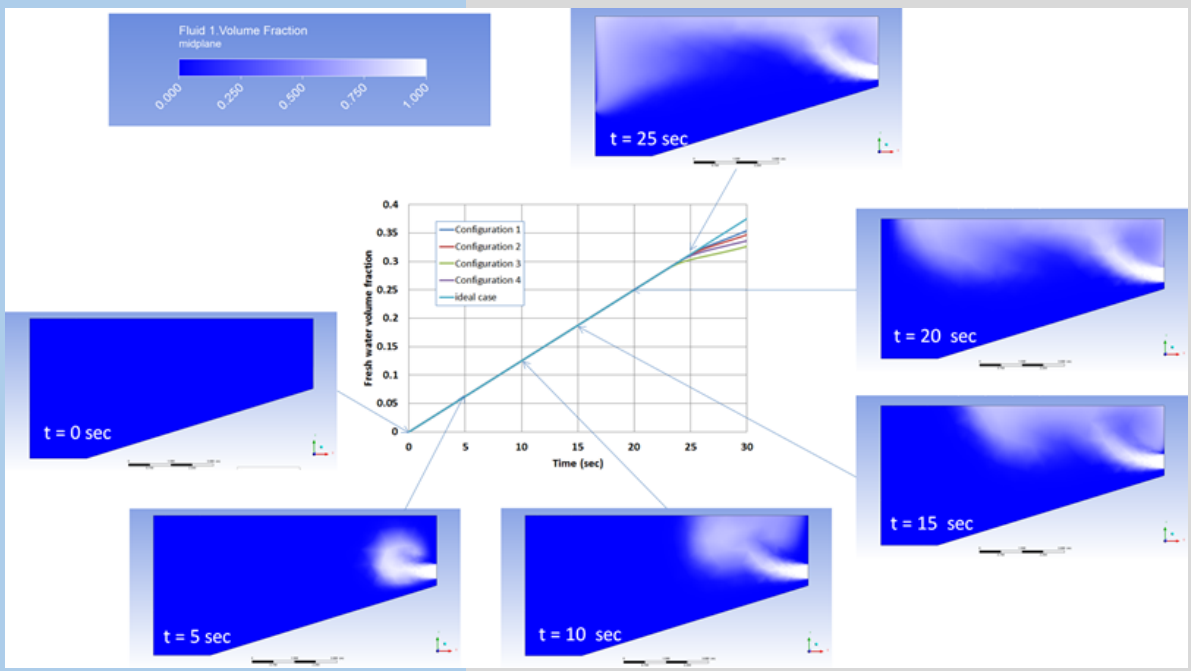



Figure 6 Detail of Figure 5: 0 --> 30 sec; progressive flushing of CR volume

# Day Zero in Chennai, India and possible CR opportunities

Dr.K.Vidhya, Professor and Head, Department of Civil Engineering,
Mahendra Engineering College (Autonomous), Namakkal - 637 503. India

Water is the most essential liquid for all the living organisms on the earth, without water none of the living organisms is going to be survived; therefore, the water conservation is the special important thing for the sustainable consumption. The available source of water is in different forms VIZ. surface water, subsurface water and Glaciers, this water is totally depended upon the downpour, out of these only few mode of available water is suitable for drinking and domestic purposes. The surface water is either running water or still water that can be effectively utilized by the action of construction of dams and reservoirs and also pool the water in the pond or lake for the future use, this water consistently not available around the year due to the temperature variance, for this reason the source of water can be stored under the ground for the abundant use, this generally termed as groundwater or subsurface water. The groundwater can be conserved for an imperishable way by adopting the suitable technology for groundwater management strategy and measures.

The Greater Chennai metro is the sixth most populous city and fourth most populous urban agglomeration in India. In Chennai City there are a lot of Automobile Industries, Electronic Hardware, Petrochemical and Textiles, many Software Industries and also the Chennai City is the best known for the major film centers and film production hubs. The Chennai city Infrastructure are premier one and it has structures like, Skyscrapers, Railway networks, Roadways and Subways and also land is covered with high density urbanized area, due to this congested network of Infrastructure amenities there is a lack of maintaining and providing the drinking water to the communities, therefore the drinking and domestic water crisis should be eradicated, to provide the water for all the people. In this regard this research article discusses about the augmentation of groundwater for the public utilization.

The geographically the Chennai is 13.08°N and 80.27°E and it is located in the south-eastern coast of India and North- eastern part of the Tamilnadu, and it is situated on the Bay of Bengal Coast. The Chennai city has two rivers namely Cooum and Adyar River that finally rest the journey at Bay of Bengal. These two rivers are highly polluted because of improper discharge of domestic sewages and dumping of municipal solid waste directly to the river. The various geological properties are underlain in the Chennai district are Archaean crystalline rocks, Consolidated Gondwana and Teritary sediments and recent alluvium these rock chiefly comprises of charnockites and gneisses. The depth of groundwater level varies from place to place and also the groundwater is increasing trend towards the post-monsoon season. The depth of groundwater level is 5.32m gbl. In Chennai there are 25 wetlands located in and around the Chennai district; these lakes are the prime source for elevating the groundwater sources.

In this article the main objective is to augment the groundwater in the Chennai City for preventing the water crisis in any season, for this one of the relevant techniques to be adopted for examining the ground profile for identifying and demarcating the Groundwater for groundwater management strategies. The Geophysical method can be utilize for understanding the ground profiles to identify the groundwater potential zones and locating the artificial recharge structures for recharging the groundwater.

The Geophysical method is one of the easiest and reliable methods for demarcating the groundwater potential zones for this Schlumberger configuration of geophysical investigation is adopted and identifying the points in and around the Chennai City and the experiment has been conducted, from that result the resistivity of ohms is calculated. The water has some ionic concentrations it has some tendency to conduct the electricity, so the resistivity is less and if the rock and pore having the least water the resistivity is more so there is no chance of groundwater occurrence. Following these principles the resistivity survey are interpreted, like-wise the resistivity survey are conducted in Chennai City for identifying the potential zones of groundwater. The resistivity data results give the thickness of each layer for situating the groundwater recharge sites, so there will be a quite chance of increase of groundwater table. The inundation due to the rainfall is the another important problem faced by the Chennai City during every monsoon, after adopting this recharge sites in and around the Chennai district the runoff flood can be controlled and subsurface water table is increased. The Desiltation of wetlands will increase the storage capacity of water, and crisis can be controlled.

The final conclusion of this article; **to replenish the groundwater quantity as well as quality by adopting suitable recharge structures in and around the Chennai City, by taking on Geophysical method to solve the water crisis and also good water management strategy to the Greater Chennai.**

# Summary of IACRR Activities & Achievements in 2020

By **Shu**-Qing Yang, Sinpoh Lim, Jacklyn Yong, and T.G. Sitharam

2020 was a special year in the world's history. A new type of world war spread to every corner like a bush fire, which started from Wuhan, China on Jan. 20. The corona virus by Dec. 10, 2020, had 72 million cases and caused 1.6 million deaths. Almost all public gatherings in the world had been ordered to be suspended, this also includes IACRR's 1st International Conference in Hohai Univ., the most important event for IACRR. Even so, the demand for sharing experience in CR technology was still high from different organizations like IAHR, FAO-UN to different countries like Malaysia, Indonesia, Singapore, India, and China. The summary of IACRR's activities in 2020 from July-Dec. is reported below:

**Sept. 3, India**. International Webinar on "Climate Change Impact on Water Resources Management and Environment" was organized by Prof. M.G. Reddy from Dept. of Civil Eng., A.U College of Engineering, Andhra Univ. Visakhapatnam. IACRR was invited to give a keynote speech about "Droughts and water management, a lesson from Murray-Darling Basin, Australia".

https://www.youtube.com/watch?v=kPhLk6KYKV0. About 171 participants from India joined the webinar (Fig. 1a)

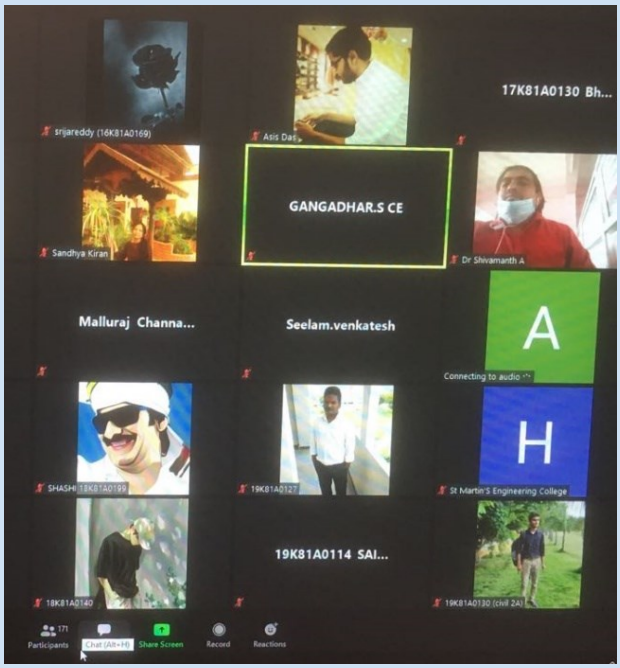



Fig. 1a

**Sept. 15, India**. MAHENDRA ENGINEERING COLLEGE (MEC) was started in 1995 in the Salem and Namakkal districts, Tamil Nadu, India. MEC conducted the AICTE –AQIS Sponsored One Week STTP Series – 3 on "LOW CARBON ENERGY BUILDINGS". In this regard, IACRR was invited to deliver a Keynote Lecture on 15.09.2020 FN. The topic given by IACRR in the seminar is "An innovative solution for low carbon energy", its analysis shows that desalination may be used for future Chennai's water supply, if so, the water crisis becomes an energy crisis at a huge cost of carbon emission. The third-generation coastal reservoir will be used for energy generation & storage with low carbon emission.

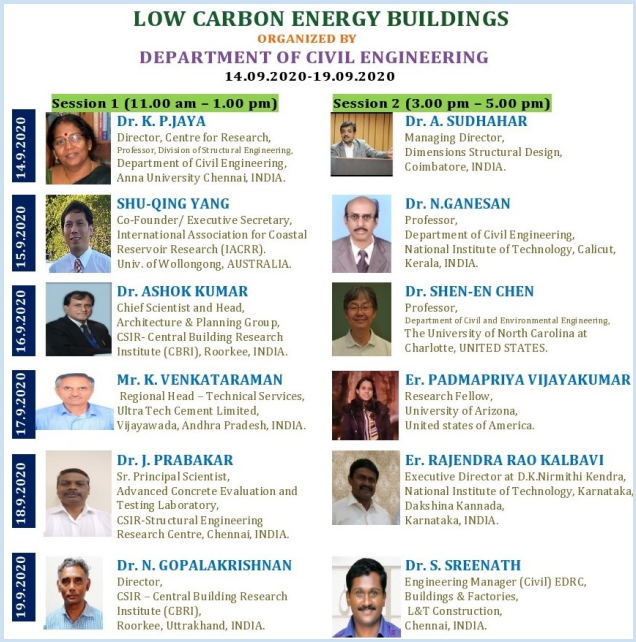



Fig. 1b

**Sept. 25/Nov. 13**, India. International Webinar Series on Hydro-diplomacy had been organized by IIT-G, The Asia Foundation, and IACRR. Prof. A. Falconer, Prof. Sivakumar, and Prof. Sitharam were invited to present their thoughts. The bonus lecture given by Prof. Falconer on Sept. 25th is "Water Security and Integrated Modelling Studies", and "Water Scarcity to security through sustainable solutions" was given by Prof. T.G. Sitharam on Nov. 13. Hydro-diplomacy is inherently political. Diplomacy is understood as the art of managing interpersonal relations, international relations by government officials in the national context. To date, however, there is a relative dearth of academic insight on water diplomacy in the social sciences, with much literature deriving instead from the natural and physical sciences. In theory, water diplomacy is relevant to all levels of water management, given that negotiations over shared water occurs at multiple levels. Yet in practice, existing policy tools of water diplomacy focus primarily on interstate interactions. Water diplomacy aims not simply to understand water cooperation and conflict, but rather to cultivate sustainable and peaceful solutions for all water users. This characteristics is frequently overlooked in more technical

approaches to water diplomacy.

| Date and time (IST) | Webinar | Panellists and lecturers (please find their details in the annexure) | Discussants (please find their details in the annexure) |
|---|---|---|---|
| 18th September 5 pm – 7 pm | Inception webinar<br><br>It will open up the series of lectures with a panel discussion.<br><br>"Water and diplomacy in South Asia" | **Opening remark**<br>Prof. T.G. Sitharam<br>Ms. Nandita Baruah<br><br>**Panel: Fundamentals of hydro-diplomacy**<br>1. Tariq Karim<br>2. Shyam Saran<br>3. Undala Alam<br>4. Mahendra P Lama | Moderated by: Anamika Barua |
| 25th September 5 pm – 6:30 pm | Bonus lecture: Water Security and Integrated Modelling Studies | Roger A Falconer | T. G. Sitharam<br>*Host and co-discussant: Anamika Barua* |
| 1st October 5 pm – 6:30 pm | Webinar 1: Power in water diplomacy | Jeroen Warner | Sumit Vij<br>*Host and co-discussant: Anamika Barua* |
| 9th October 5 pm – 6:30 pm | Webinar 2: Communication and media in water diplomacy | Emanuele Fantini | Joydeep Gupta<br>*Host and co-discussant: Anamika Barua* |
| 16th October 3 pm – 4:30 pm | Webinar 3: Gender and hydro-diplomacy | Kuntala Lahiri-Dutt | Jennifer Sehring<br>*Host and co-discussant: Anamika Barua* |
| 21st October 5 pm – 6:30 pm | Webinar 4: Transboundary Water Conflict and Cooperation | Mark Zeitoun | Selina Ho<br>*Host and co-discussant: Anamika Barua* |
| 30th October 6:30 pm – 8 pm | Webinar 5: International Water Laws | Christina Leb | Lena Salamé<br>*Host and co-discussant: Anamika Barua* |
| 6th November 6:30 pm – 8 pm | Webinar 6: Mediation, dispute resolution and conflict management in hydro-diplomacy | Aaron T. Wolf | Zaki Shubber<br>*Host and co-discussant: Anamika Barua* |
| 12th November 3 pm – 4:30 pm | Bonus lecture 7: Rising water scarcity and sustainable solutions | Mothcumaru Sivakumar | Arup Kumar Sarma<br>*Host and co-discussant: Anamika Barua* |


In the context of the Sustainable Development Goals seeking better conservation of water resources and parallel changes in national interests and the geopolitics of the region, there is an urgent need for an interdisciplinary and non-politicized approach to transboundary water cooperation, in line with the international principles to "not cause significant harm" to other riparian countries and "reasonable and equitable use" of scarce water resources.

Obviously, as the president of IACRR, Prof. Sitharam is shaping IIT-G as the world's water hub from research to practice, from politicians to the public, and from local government to inter-government.

**Oct. 14, CME, UOW, Australia**. A zoom seminar was organized by the school of Civil, Mining and Environmental Eng., Univ. of Wollongong to discuss an interesting topic: Australia is a paradise or hell", this is an extension of an old debate in Australian parliament: Can Australia be developed as powerful as USA? Table 1 shows that both USA and Australia are similar in terms of history, territory size, natural disasters, resources. In fact, **Australia even is better than the USA except for the water resources which lead to the biggest difference in terms of population ratio (25million/327 million), GDP (US$1.4trillion/20.5 trillion).** Tables 2 and 3 show the similarities/differences in rivers and the city's water supply technology, Australia could be developed as powerful as the USA even the island country's coastline is wet and dams cannot harvest its rainfall, whilst the coastal reservoirs can harvest every drop from this dry land and reuse the rainwater again and again. Its agricultural water supply should come from the coastal reservoirs and its coastal cities like Adelaide should depend on coastal reservoirs, rather than desalination plants as the Alexandrina lake is similar to the Hoover Dam in the Colorado River. It is totally unacceptable for Australia water experts to have 5000-6000GL/year of water lost to the sea from Murray River intentionally using the excuse of "good environment". This seminar concludes that **Australia is a paradise if the government is smart to manage its water, i.e., using coastal reservoirs to harvest the rainwater, reusing the river water again and again.** If so, Australia is no longer a water-scarce country, and it has the potential to be developed as powerful as the USA.

| | Year discovered | Area (m km$^2$) | Land >610m | Mean elevation | disasters | Resour. | Rainfall (mm/yr) | Runoff (km$^3$/yr) |
|---|---|---|---|---|---|---|---|---|
| Australia | 1788 | 7.7 | 7% | 330m | low | Coal | 465 | 420 |
| USA | 1776 | 7.8 | 58% | 760m | High | Coal | 793 | 3069 |

Table 1, comparison of natural conditions between USA and Australia.

| | Murray River | Colorado River |
|---|---|---|
| Length (km) | 3370 | 2334 |
| Catchment (km$^2$) | 1,061,000 | 637,000 |
| mean runoff Q | 11,500(GL/year) | 20,700(GL/year) |
| Minimum Q | 20 (at Lock 1) | 12m$^3$/s (Topock) |
| Runoff to the sea | 5000-6000GL/yr | 0 |

Table 2, the comparison of Murray-Darling river basin in Australia and Colorado

| | Adelaide | Las Vegas |
|---|---|---|
| Population in 2015 | 1.32 million | 2.09 million |
| Area ($km^2$) | 3257 | 1600 |
| Annual rainfall (mm) | 544 | 110 |
| Distance to a river | 60km | 55km |

Table 3, Adelaide and Las Vegas' comparison

It is concluded (https://www.youtube.com/watch?v=tkJrfD8D2EE&t=15s) that Australia will be always a second-class country in the world because of its water scarcity in the world's driest inhabited continent. But, by applying the coastal reservoir technology, Australia could be as powerful as USA.


**Oct. 26-27, Indonesia**. In 2020, the most important event organized by IACRR was the "International Workshop on Coastal Reservoirs" invited by the Ministry of National Development Planning and Indonesia Engineers Institute.

As a country located on the equator, Indonesia has a high rainfall between 2,000 mm to 3,000 mm per year, even Indonesia is a water-rich country, there are still fundamental problems in its water crisis. During the rainy season, several parts of Indonesia experience an extraordinary abundance of water, which causes flooding and other damages. On the other hand, during the dry season in several areas, Indonesia experiences water shortages and drought. The over-crowded Java Island has experienced disasters like floods, droughts, water pollution and, groundwater depletion that causes its capital city's subsidence and forces the country to relocate its capital to Kalimantan. Can coastal reservoirs solve these problems?

The total population in Indonesia is estimated to exceed 280 million people by 2020 and about 60% of the population lives on Java and Bali Islands, even though the islands are only 7% of Indonesia's land area. World Bank's analysis shows that with current dams' storage capacity, the water shortages may cause the country's GDP losses by 0.59% to 2.5% in 2045 in the wet and dry years respectively. World Bank recommends that Indonesia needs additional water storage above 50 km3 by 2030. In the Pacific Fire Ring, more dams mean that more "Sword of Damocles" above the people's head, therefore, increasing dam numbers will also cause GDP losses, even catastrophic consequents.

Different from the dilemma by the World Bank's recommendation, IACRR recommends that the water storages should be constructed in the sea, not the mountainous area. By doing so, the following effects can be achieved:

1. The Giant Seawall project in Jakarta Bay can function as a combination of groundwater dam and coastal reservoirs, which can enhance the groundwater table of the whole city if the coastal reservoirs' water table is 1m above the sea-level. One of the pools can be used for high-quality water storage, the other for treatment of the worst quality water.

2. The Cisadane River and the Cileeungsi River can be used as floodwater's by-pass channel (BPC) to protect the Jakarta if SPP strategy is applied. If so, the clean water at these outlets can be stored in the coastal reservoirs for the great Jakarta's water supply. If so, the Giant Seawall project may need to be modified.

In the workshop it was noted that 1100 people registered with the final verification result of 915 people who could follow through with the Zoom application, and the remaining 75 people were recommended through a YouTube channel called KMC DIPI Bappenas. A total of 85 seats were reserved for the panellist and several guests who were invited directly.

After registration is closed, we change the editorial of the registration page with information to participate in the event through the YouTube channel listed. On the event day, more than 700 people were visiting the page after registration was closed. Enthusiasm is also seen with the many comments and responses on the live chat on the YouTube channel. The organizing committee also responded cooperatively to comments and questions from participants.

Now the workshop is ready on the website for everyone to watch. By Dec. 14, there were 2.3k viewers for Day 1's video and 1.1k viewers for Day 2's activities:

https://www.youtube.com/watch?v=A7veD3eklo&t=9s (Introduction)

https://www.youtube.com/watch?v=UBJiYAElqbc&feature=youtu.be (Day 1)

https://www.youtube.com/watch?v=pw6Kqn28HjE (Day 2)

It is important to note that the Minister of National Development Planning Agency, Mr. Suharso Monoarfa, announced (at 36"00 of Day 1 VIDEO) that **the 2nd generation coastal reservoir is expected to be the solution to water shortage and coastal flooding problems in northern coastal Java, adding coastal reservoirs to north Java plan is mandatory**. Jakarta Post, the major newspaper in Indonesia also reported on Oct. 27, 2020 that the minister considered developing coastal reservoirs an ideal solution in areas as densely populated as Java given that their development would not use up existing land. IACRR is expected to collaborate with the Indonesian government and engineers to make these CRs successful.

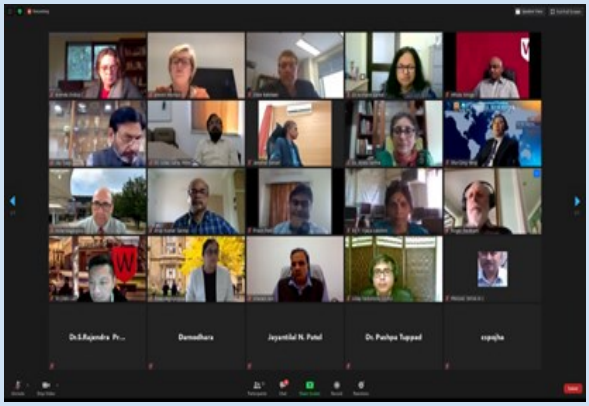

**Nov. 6, AIWC**. Under UOW's financial support, IACRR president, Prof. Sitharam visited Australia's universities from UOW to UTS and WSU, from Sydney to Melbourne and other places in June 2019. Consequently, a virtual Australia-India Water Center was established from this successful visit. The Centre provides a platform for long-term partnerships and dialogue between Australian and Indian water researchers, policymakers, industry partners and non-governmental organisations. Its members included Australia Partners: 1) Western Sydney University (lead); 2) Deakin University; 3) Flinders University; 4) Queensland University of Technology; 5) The University of Melbourne; 6) The University of New South Wales; 7) The University of Western Australia; 8) The University of Wollongong; as well as India partners: 1) Indian Institute of Technology Guwahati (lead); 2) Banaras Hindu University, Varanasi; 3) GB Pant University of Technology and Agriculture, Pantnagar; 4) Indian Institute of Science, Bangalore; 5) Indian Institute of Technology, Kharagpu; 6) India Institute of Technology, Roorkee; 7) Jawaharlal Nehru Technological University, Hyderabad; 8) Maharana Pratap University of Agriculture and Technology, Udaipur; 8) National Institute of Technology, Surathkal; 9) SV National Institute of Technology, Surat; 10) University of Agricultural Sciences, Bangalore.

In the virtual launch of AIWC that took place on 6th Nov 2020, an MOU was signed by a consortium of 9 Australian and 15 Indian Universities and Institutes to promote cooperation and collaboration in water research, education, training, and capacity building. Australia and India both face challenges to water security in both cities and towns. The spatial and temporal variation of water availability to satisfy the ever-growing water demand for agricultural, industrial, domestic and, environmental

Hon Dan Tehan, Minister for Education Commonwealth of Australia

sectors poses special challenges in light of climate change. There is a lack of suitable water storage, particularly in coastal areas. The virtual launch of the AIWC has been organised by the Western Sydney University (Australia-led) and Indian Institute of Technology Guwahati (India lead) and attended by the VCs and water researchers of most universities as well as the following dignitaries: AUSTRALIAN HIGH COMMISSIONER TO INDIA, His Excellency The Hon. Barry O'Farrell; INDIAN HIGH COMMISSIONER TO AUSTRALIA His Excellency The Hon. A. Gitesh Sarma; MINISTER FOR EDUCATION, Commonwealth of AUSTRALIA, The Hon. Dan Tehan MP; UNION CABINET MINISTER, MINISTRY OF JAL SHAKTI (Water and Energy), REPUBLIC OF INDIA The Hon. Sh. Gajendra Singh Shekhawat.

AIWC will certainly be a hub for IIT-G and UOW to influence Australian and Indian water industry for using coastal reservoirs, including training, project application, and research. This will also influence other countries. There was good media coverage in English and Hindi newspapers in India.

**Nov. 25, FAO**. With the recommendation of IAHR, IACRR was invited to attend a UN level meeting in Sept. 2019 (see IACRR newsletter 2020-1), as an echo of CR promotion to UN-water, Food and Agriculture Organization (FAO) expressed its interest to know more about how CRs will fundamentally change the future agriculture and food supply. The topic is "Coastal reservoirs may supply sufficient water for coastal agriculture.

Now, 2 billion people did not have regular access to safe, nutritious and sufficient food in 2019. To end this, double agricultural productivity is needed by 2030 and this has been listed in the UN 2030 Agenda. The data show that irrigated land and water have reached its maximum capacity, and many countries like Australia have reduced water allocated for agricultural development. Currently, in many places, the irrigated water comes from groundwater and dams. After the 21st century, the world has constructed few new dams and the existing dams are aging, all of these make FAO difficult to achieve the SDG2.

The new technologies of seawater rice and coastal reservoir may bring the world new hope. This seminar reveals that coastal agriculture may be the main food supplier due to its availability of vast barren land and river water. **Currently, the world only uses 5.8% of available water lost to the sea for irrigation and 60% of cultivated land has the problem caused by saline or sodic soil. Once coastal reservoirs are constructed, agriculture within 200km of coastline will thrive due to abundant freshwater.** A vivid example from Australia's food bowl is provided to indicate that dam water supply has led to the shrinkage of agricultural activities, but China and India start to develop the coastal land and water resources. Singapore has constructed many coastal reservoirs, the same can be extended to other islands like Indonesia from domestic to agricultural purposes. **The dilemma of environment-food-energy nexus can be well solved by reusing river water once coastal reservoirs are constructed.**

More importantly, coastal reservoirs will bring soilless agriculture from the land area to the continental shelves using floating greenhouses. It is expected that Singapore may lead to the agricultural revolution in history. The information can be found from https://www.youtube.com/watch?v=POxLoNOcmG0&t=1451s

**Dec. 2, Malaysia**. The 11th ASIAWATER Exhibition and Conference aim at their innovations and solutions in water management, sewerage, industrial wastewater, purification, irrigation, and water resource management, with full support from the Ministry of Environment and Water (KASA), National Water Services Commission (SPAN), The Malaysian

Water Association (MWA). It is a one-stop platform and in developing Asia. The main objective of ASIAWATER is to act as a comprehensive resource regional hub for the water and wastewater industry for the industry, its members, prospective business visitors, and consumers by providing in-depth information about the water & sanitation industry and the latest trends influencing its progress.

The central theme of free-to-attend virtual conference and seminars "Water for Health is Water for Wealth" led by industry experts addressed the opportunities, latest technologies, and challenges within the water and wastewater industry. The conference also aimed to focus on the transformation of and improvements to our region's water and wastewater industry services, especially concerning to current world events.

IACRR was invited to give a presentation "Coastal Reservoir / Off River Storage - Case Study in Shanghai and Malaysia". The currently available water solutions are unable to satisfy people's increasing need for water. Without sustainable water supply, there is no sustainable development for any country/region as clean water can impact the health, prosperity, food security, and livelihoods. Currently for water supply, there exist many water solutions like desalination, wastewater reuse, inland dams, water diversion from remote sources and coastal reservoir. All these techniques have their own disadvantages. The site of inland dams relies on the ideal combination of topography, hydrology, and geology, generally, only part of rainwater from 1/3-1/2 of a catchment can be collected. Coastal reservoir is a freshwater storage in the sea to harvest river flow before it mixes with seawater. Currently, 50% of global pollution and 80% of mega-cities are located on the coastline. However, the world only uses 5~6% of runoff lost to the sea. In this talk, the newly emerging concept of storing floodwater in the sea closed to the shoreline is presented. The successful example in Shanghai is discussed and compared with other CRs, and the application of CR technology to Malaysia is also discussed.


**Dec., 11, Coastlab 20**. IACRR council member, Prof. Pengzhi Lin, and others organized the 8th International Conference on the Application of Physical Modelling in Coastal and Port Engineering and Science (CoastLab2020) during the 9th-12th of December 2020 in Zhoushan, China under the auspices of the International Association of Hydro-Environment Engineering and Research (IAHR). It was jointly hosted by Zhejiang University, Dalian University of Technology, Sichuan University and Zhejiang Ocean University, and co-organized by Bureau of Science and Technology of Zhoushan, Hohai University, Nanjing Hydraulic Research Institute, Ningbo University, Journal of Marine Science and Engineering, Key Laboratory of Offshore Geotechnics and Material of Zhejiang Province, International Joint Research Center for Offshore Civil Engineering (Ministry of Science and Technology of the People's Republic of China), the Engineering Research Center of Oceanic Sensing Technology and Equipment (Ministry of Education of the People's Republic of China). The Coastlab2020 was part of the celebration programs of IAHR's 85th anniversary. The president of IAHR, Prof. Joseph H.W. Lee, was guest of honor during the opening ceremony!

During this big world event that more than 200k people attended and watched the presentations, IACRR was invited to have a special session. In total, 10 papers were present in two sessions as shown below:

| Friday, 11th December (209, Teaching Building) | |
|---|---|
| **Chairs: Guangqiu Jin, Ji Chen** | |
| 9:00-9:25<br>Online keynote | How to design a coastal reservoir?<br>Shuqing Yang (University of Wollongong) |
| 9:25-9:40<br>On-site | Two-Phase Risk Hedging Rules for Informing Conservation of Flood Resources in Reservoir Operation Considering Inflow Forecast Uncertainty<br>Bin Xu (Hohai University) |
| 9:40-9:55<br>On-site | Simulation of dam-break flow through porous media by wc-mps mesh-free method<br>Tibing Xu (Ningbo University) |
| 9:55-10:10<br>Online | The opportunities and challenges of coastal reservoir strategy for sustainable water resources development<br>Honnasiddaiah Ramesh (National Institute of Technology Karnataka) |
| 10:10-10:30 | Tea break |
| **Chairs: Shuqing Yang, Tibing Xu** | |
| 10:30-10:55<br>On-site keynote | Hydrological processes in the surrounding aquifer affact the salt dynamics in the coastal reservoir<br>Guangqiu Jin (Hohai University) |
| 10:55-11:10<br>Online | A new perspective of acquiring water resources for coastal regions: utilization of atmospheric water resources<br>Ji Chen (The University of Hong Kong) |
| 11:10-11:25<br>Online | Numerical Study of Brisbane River Estuary and Moreton Bay<br>Khalil Usman (University of Wollongong) |
| 11:25-11:40<br>On-site | The influence of the dam/cut-off wall on seawater intrusion in coastal reservoirs<br>Chaoqun Xu, Yuhang Tian, Jicong Xie (Hohai University) |
| 11:40-11:55<br>Online | Hydro-environmental modelling of North Wales Tidal Lagoon using Telemac-2D<br>Bin Guo (Cardiff University,) |
| 11:55-12:10<br>Online | Mechanism of sediment transport beneath the tidal wave and experimental verification<br>Muhammad Zain Bin Riaz (University of Wollongong) |

# Coastal Reservoir for South East QUEENSLAND, AUSTRALIA water security

Usman Khalil [1], Shuqing Yang [2] & Muttucumaru Sivakumar [3] Mariam Sajid [4]

[1,2,3] University of Wollongong, NSW Australia

[4]University of Engineering and Technology Lahore, Pakistan

## INTRODUCTION:

Australia has a long history drought. Australia is also among one of the driest countries and continent (Donohue et al., 2009). Australia, during the last two centuries i.e. 1803 to 2010, has been experienced by ten spells of severe droughts. The period for each drought varies between 2 to 8 years. From 2000 to 2013, considerable southern and central inland has experienced nearly seven years of extreme drought, and few places remained 10 years in drought; it is identified as the Millennium Drought of Australia (BCC, 2012), where the South East Queensland (SEQ) dams water was reduced to 20 % in 2007.

The region required 500 GL additional water supply for future needs (Yang, 2015), the region needs to look for other water resource options, (Seqwater, 2016) region require new water resources.

It is therefore essential to evaluate water resources in current and future conditions for long-term sustainable development in this Brisbane river basin. Coastal Reservoir technique is used for water storage in Brisbane River Estuary (BRE) (Figure 1).

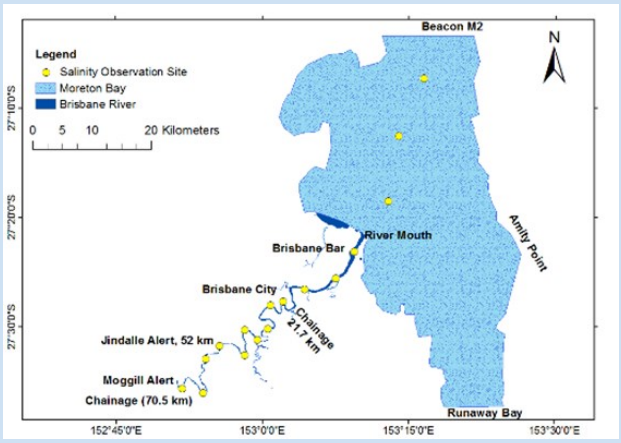



Figure 1. The Brisbane River estuary (BRE), Queensland, Australia, and locations of observation sites along the estuary

## HIGHLIGHTS

- MIKE-21 model was used to simulate flow hydrodynamics in Brisbane River estuary estuaries.
- A Coastal Reservoir technique was used for water resource development in Brisbane River estuary.
- A discharge of 150 m3/sec can flush salinity Brisbane river estuary up to the river in 302 hours.
- The coastal reservoir could store water when the flow will be more than 150 m$^3$/sec in the estuary.

## METHODOLOGY/ PROCESS

The Flow Model FM of MIKE 21 is being used for hydrodynamic and salinity change simulation in the BRE. The MIKE 21 FM hydrodynamic model is set up with topographic data, Manning's roughness coefficients, water level and tidal data for the year 2011.

Monthly interval salinity data across BRE and Moreton bay from 2002-2018 were collected from Ecosystem Health Monitoring Program (EHMP). EHMP has been conducted water sampling at the ebb tides at 16 monitoring sites as shown in Figure. 1. Salinity data is taken by using YSI 6920 conductivity sensor (Yu et al., 2014) and it is expressed using practical salinity unit (PSU). The measured monthly depth-averaged salinity data in BRE is plotted as shown in Figure. 2

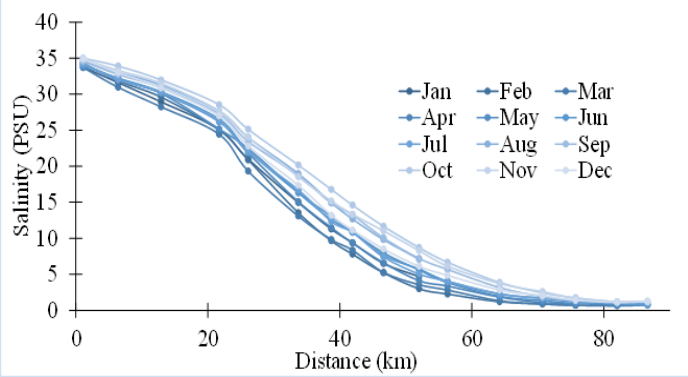



Figure 2. Observed monthly averaged Salinity Data in BRE over 16 years from 2002 to 2018

For CR design, it is essential to monitor estuary water salinity for long period to determine the flow quality at intake and the CR's (Figure 3) stored water must be as devoid of salinity as likely, to use for water supply, etc. However, salt water can enter the CR via seawater seepage as well as possible overtopping in extreme storm events. Further, during the early stages of the CR's filling, saltwater removal can take up to a few years subject to the water exchange processes (Sitharam et al., 2020). For instance, reservoir saline water conversion to freshwater ranges from 0.5 years (e.g., Qingcaosha), 2 years (e.g., Marina Barrage) and 5 years (e.g., Zuider Zee) (Yang, 2015). Thus for CR design, salinity modelling is performed in BRE to determine flushing time at intake to see how salt devoid water can be diverted into CR. Further, suitable engineering measures are utilised to control seawater intrusion

and reduce the flushing time in BRE.

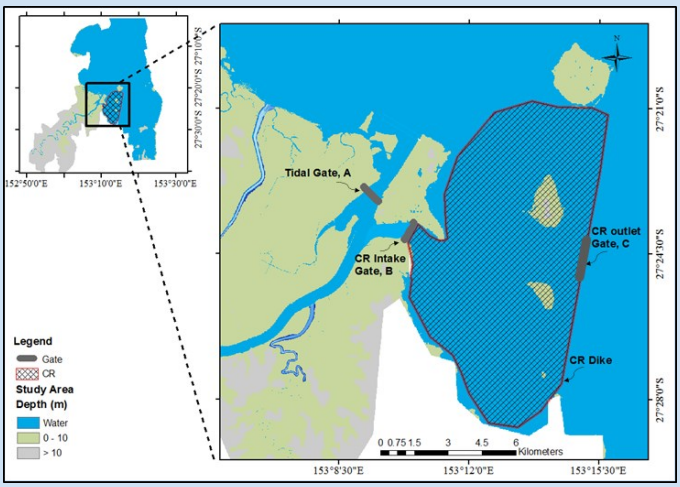



Figure 3. Proposed CR for Brisbane River

## RESULTS/ OUTCOMES

The simulated salinity compared well with the measured salinity measurements in BRE with a correlation coefficient of 0.90 (Figure 4).

To determine the flushing time in the BRE, various freshwater flows were selected based on the minimum and maximum discharges from 1958 - 2020, with a range of 5 to 10,000 $m^3/s$. As discharges increase to and more than 150 $m^3/sec$ BRE flushed up to mouth and flushing time fluctuates substantially due to increasing in discharges, changing between 11 h at 10,000 $m^3/s$ and 302 h at 150 $m^3/s$.

The location of the Fresh and saltwater interface (FSI) mainly depend on the freshwater supply, the distance of the FSI from the mouth X is presented as a function of freshwater supply in Figure 5a. A regression line forecasting FSI location in terms of freshwater supply is drawn. The regression relationship between FSI position and freshwater supply is ($X = 0.0047Q^2 - 1.1424Q + 72.174$). FSI location shifted towards the mouth with the increase in river discharge, and it became quite close to BRE mouth with 125 $m^3/sec$ flow. However, with the discharge more than 150 $m^3/sec$, BRE flushed as shown in Figure 5b.

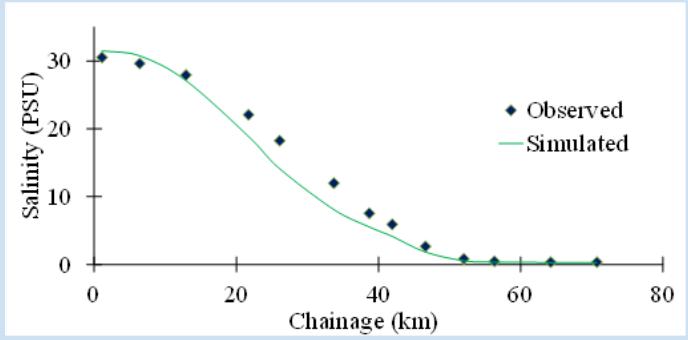



Figure 4: Comparison of observed and simulated salinity, 2011

## Conclusion

To mitigate coastal city's water shortage, we analysed the feasibility of a proposed CR at the mouth of Brisbane River estuary (BRE) in Moreton Bay to store the excess water. The proposed coastal reservoir is justified based on technical feasibility, water quality and water supply reliability. MIKE 21 FM, hydrodynamic module (HD) coupled with the transport module (TR) was used to simulate flow hydrodynamics and salinity intrusion in BRE.

The simulation to investigate the impact of the various river flow on flushing times in the BRE under a neap - spring tidal cycle reveals that freshwater discharge of 150 m3/sec restricts the saline water intrusion up to BRE mouth.

This preliminary investigation provides a promising way for other coastal cities to mitigate the water shortage that is threatened by climate change and sea-level rise. A CR has great potential to store the water of the Brisbane catchment and thus to mitigate Brisbane region water shortage.

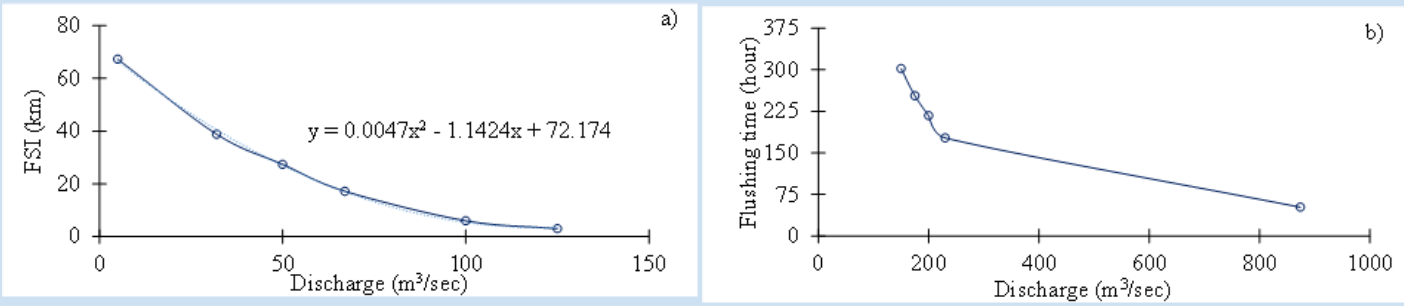



Figure 5. a) Freshwater and saline water interface (FSI); b) flushing time for various flows

# Welcome to IACRR new members

**vice-president**
**Prof. Glen Daigger, past president of IWA, USA (2010-2014)**
**E-Mail: gdaigger@umich.edu**

**Member**
**Ir Yuliang Gu, General Manger of NERC, China. Master Planner of Qingcaosha CR, Shanghai, China**
**E-Mail: gylqcs@163.com**

**Member**
**Prof. Arthur Mynett, Vice president of IAHR, the Netherlands**
**E-Mail: arthur.mynett@gmail.com**

**Member**
**Prof. KANSAL, IIT, Roorkee, India**
**E-Mail: mlkfwt@iitr.ac.in**

**Member**
**Dr. Basanta Kumar Jena, NIOT, India**
**E-Mail: bkjena.niot@gov.in**

**Member**
**Dato' Ir. Haji Nor Hisham, Director General,Dept of Irrigation & Drainage Malaysia, Malaysia**
**E-Mail: hisham@water.gov.my**

IACRR management team has been strengthened by the new members from China, India, USA, Malaysia and Europe. It is certain that they will bring IACRR to a higher level with wider impacts.

Among them, Ir. Yuliang Gu is the master planner of Qingcaosha coastal reservoir. Back to early 1990s, the world including World Bank and UN had predicted that Shanghai would suffer from severe water shortage problem induced by pollution, even China Water Ministry also listed Shanghai as one of its 7 mega cities with the worst water crisis. Similar to other cities many suggestions were flooded to city council like water diversion from a remote source (like Beijing), recycling sewer water (like Singapore, Brisbane and Adelaide), desalination (like Singapore, Melbourne, Perth, London and Adelaide), Shanghai is the only city at the same time for the same water problem that the 2nd generation coastal reservoir is used to harvest the runoff, otherwise lost to the sea. Shanghai's CRs now provide about 75% of water supply for its 24 million people. Ir Gu's contribution is widely recognized, without him, Shanghai may use another water solution like other cities. It is certain that Shanghai's model will influence more and more cities to shift their water plan from desalination plants.

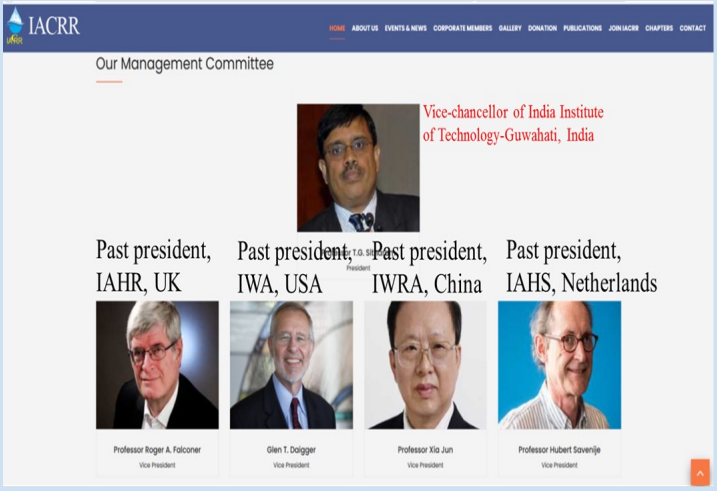
Arthur Mynett (1950) is Emeritus Professor of Hydraulic Engineering and Environmental Hydroinformatics at IHE Delft Institute for Water Education and Delft University of Technology. He received his MSc degree in Civil Engineering from Delft University (1976) and ScD degree in Hydrodynamics & Coastal Engineering from the Massachusetts Institute of Technology (1980). He was employed at Delft Hydraulics (1980-2010) and at IHE Delft (1985-2015). He worked in various fields of river, coastal and offshore engineering, and became director of strategic research & development at Delft Hydraulics (1995). At IHE Delft he served as professor of Environmental Hydroinformatics (1997), chair professor of the Hydraulic Engineering & River Basin Development group (2010), and head of the Water Science & Engineering department (2011-2015). He holds numerous international appointments and awards, including visiting professor at the Iowa Institute of Hydraulic Research (2005), adjunct professor at the Chinese Academy of Science (2007), visiting professor at Sichuan University in Chengdu (2011), honorary professor at the Nanjing Hydraulic Research Institute, China (2015). Prof Mynett was chair of the LOC of the 36th IAHR World Congress held in 2015 in Delft / The Hague in the Netherlands. He is an IAHR Life Time Member (2016) and Honorary Member (2019).

Prof. M.L. Kansak is the head Of Department of Water Resource Development & Management, IIT, Roorkee. He is the founder President of North India Chapter of Environmental & Water Resources institute (EWRI) of ASCE, USA from 2010 onwards. He is the life Fellowship of Institution of Engineers (India), Charted Engineer (I), Institution of Engineers, India; Indian Water Works Association(FIWWA); Indian Water Resources Society(FIWWA); Indian Association of Hydrologists (FIAH).

Dr. Jena is a senior expert from National Institute of Ocean Technology, Chennai, India. His city is the world 1st city claimed "Day zero" in June 2019 officially, meaning that all taps in the city ran dry without drips. Dr. Jena is Associate member at ASCE, USA, American Society of Civil Engineers since 2003, Member the Board of Governors of the Coasts, Ocean, Ports, and Rivers Institute, USA, Since 2003. Life Member Ocean Society of India, Since 2008, Secretary for Ocean Society of India (OSI), Chennai Chapter since 2011 and EADA since 2018. He conducted research for the largest CR in India, across Gulf of Khambhat in 2012-2016 invited by State Government of Gujarat. He was in charge of marine and Ocean observations like 24 met-ocean observatory network operating for two years cycle for parameters like tide, currents, wind speed, direction, temperature, humidity, radiation and pressure. As the project leader, he has made great contribution for the data collection by monitoring and management, developing methodology., including field based Conceptual design of solutions to accurately measure the Ocean State Parameters.

IACRR is very proud of having prof. Glen Daigger on board. Prof. Daigger is currently Professor of Engineering Practice at the University of Michigan and also President and Founder of One Water Solutions, an Engineering and Innovation firm. He was President of the International Water Association from 2010 till 2014. Widely recognized for his contributions, he has received a number of national and international awards and he also served as Professor and Chair of Environmental Systems Engineering at Clemson University, and is a member of the US National Academy of Engineering.
Over his career Glen Daigger has become an internationally recognized expert in wastewater treatment and water quality management for municipal and industrial systems, with particular expertise in biological processes. He is widely published and is author or co-author of more than 200 technical papers, four books, and several technical manuals. He has served in senior roles for the Water Environment Federation, the American Academy of Environmental Engineers, and the Water Environment Research Foundation.
Glen Daigger was a Senior Vice President and Chief Technology officer for CH2M HILL, where he was employed for over 35 years. An international consulting engineering firm with projects for major cities such as New York, Washington DC, Indianapolis, Milwaukee, Atlanta, Denver, Dallas, Los Angles, Portland, Seattle, Anchorage, Auckland, Sydney, Melbourne, Singapore, Abu Dhabi, Bangkok, and Beijing, along with numerous small to medium sized communities. These projects are advancing approaches for managing and reusing/recycling water while also protecting and enhancing the environment.

As shown in the following figure, IACRR is unique in the world whose management team includes past presidents of IAHR, IAHS, IWRA and IWA, the world's mainstream water associations. Their endorsement clearly reveals that CRs will dominate future water supply as 50% of global population is living in the coastal areas and its growth rate is much higher than inland regions. Their background includes geotechnical, hydraulics/environment, water quality/ treatment, water resources eng and hydrology/ estuary hydrodynamics. The nationality of council members covers India, China, USA, UK, Netherland, Malaysia, Indonesia, Australia. These countries have about 50% of the world total population and land area. In the future, IACRR needs to develop its members from Africa and South America.




**IACRR welcome its new corporate members Prof. Jianhua Li from Tongji Univ. and Jiangsu Qiyue Engineering Management Co., Ltd. Both are from China.**


**PROF. Li jianhua, Tongji Univ.**

**Managing director, Wang Ruiying, Qiyue Co.**

Jiangsu Qiyue Engineering Management Co., Ltd. was established on February 19th, 2004, which is a limited liability company and belongs to the consulting service industry. The company's registered capital is 5 million yuan, and the office is located in Building 24, Tus Fashion City, No.58, Weixin Road, Suzhou Industrial Park. The company's business scope: engi-neering project management, engineering cost consulting, engineering investment consulting, engineering bidding agency, engineering supervision, real estate evaluation, government procurement bidding agency and consulting services.

The company has 156 employees：14 senior engineers; 35 registered cost engineers; 2 registered consultants; 30 registered second-level builders; 10 registered first-level architects; 5 senior engineering cost editors and reviewers, and intermediate engineering cost editors and reviewers 59 people. Majors include：project management, civil engineering, municipal administration, decoration, installation, antique building, landscaping, civil air defense, building repair and other pre-tender estimate preparation, PMP, IPMP, MRICS, settlement audit, reinforced lofting, cost estimation, budget making, bidding agency and government procurement, etc.

The name of Jiangsu Qiyue Engineering Management Co., Ltd comes from "inspire the future and move towards excellence", with "independence, objectivity, fairness, and integrity" as its service tenet, and "becomes the leader of China's engineering project management industry" as its lofty mission, as well as carries forward the enterprise spirit of "doing things with heart, doing things with life".The company always take achievements as a new starting point, constantly forge ahead, to provide project investors with comprehensive, systematic and professional whole-process project management services, in order to maximize investment returns and social benefits.

Prof. Jianhua LI is Deputy Director of Key Laboratory of Yangtze River Water Environment, Ministry of Education of China. Tongji Univ. is one of the best universities in China, No. 1 in civil eng., The College of Environmental Science and Engineering, Tongji Univ. was the earliest teaching and research institution in the field of environmental science and engineering in the form of a college among the institutions of higher learning in China in 1980s. The college consists of three departments: the Department of Environmental Science, the Department of Environmental Engineering and the Department of Municipal Works (Water Supply and Sewage) and five research institutes: Water Pollution Control and Resource Reuse, Urban Water Resources and Water Supply, Solid Water Disposal and Reuse, Air Pollution Control, and Environmental Science.

Currently, the College comprises three specialty programs: Environmental Science, Environmental Engineering and Water and Waste Water Engineering at undergraduate and postgraduate levels. (These programs are referred to as Municipal Engineering at the postgraduate level), all with

undergraduate, master, doctor, and post-doctorial programs. Its three Master's programs are further sub-categorized into fourteen research directions while its three PhD programs into twelve research directions.

Under the College, there are research and education units under state level supervision including the State Key Laboratory of Pollution Control and Resource Reuse, National Engineering Research Center of Urban Pollution Control, SEPA-Tongji Research Institute of Environmental Science and Technology, SEPA-Tongji Center of Environmental Technical Officers, etc.
Over the years, about 7000 Bachelor students and 400 Master students and 100 PhD students have graduated from the College. The College is known for its strong expertise in the field of environmental science and engineering in China. At present, there are 20 PhD student supervisors, 25 professors and 32 associate professors in the College. The College has enjoyed a good reputation both at home and abroad for its new system of integrating teaching with research and service.

**List of IACRR founding corporate members** (https://www.iacrr.org/corporate)

| No. | Institution / Organization | Country |
|---|---|---|
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| 2. | Wuhan University | China |
| 3. | SGES Pvt Ltd | India |
| 4. | Zhejiang Institute of Hydraulics & Estuary | China |
| 5. | Jiangsu Qiyue Engineering Management Co., Ltd | China |
| 6. | Tongji University | China |
| 7. | Shanghai National Engineering Research Centre of Urban Water Resources Ltd | China |
| 8. | DLH engineer consulting corporate | China (construction) |
| 9. | Nanning Normal University | China |
| 10. | Sichuan University | China |
| 11. | China Agricultural University | China |
| 12. | Cintalam Sdn Bhd | Malaysia |
| 13. | Hohai University | China |
| 14. | One Ocean Environment Sdn Bhd | Malaysia |
| 15. | Global Water Consultants Sdn Bhd (Formerly known as G&P Water & Maritime Sdn Bhd) | Malaysia |
| 16. | TNB Research Sdn Bhd | Malaysia |
| 17. | YBIT Sdn Bhd | Malaysia |
| 18 | Department of Civil Engineering Indian Institute of Science | India |
| 19 | Dalian University of Technology | China |
| 20 | Beijing Normal University y | China |
| 21 | Ocean University of China | China |
| 22 | Maverrick United | Malaysia |
| 23 | ACMF Advisory Sdn Bhd | Malaysia |

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partha@sarathygeotech.com

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**Prof. Dr. Pengzhi Lin**
cvelinpz@126.com

**JinQuan Wu**
wujinquan@fdine.net

**Prof. R. Subba Rao**
rramrita@gmail.com

**Kushal Shetty**
Kushalshetty1953@gmail.com

**Ir Yuliang Gu**
gylqcs@163.com

**Prof. Arthur Mynett**
arthur.mynett@gmail.com

**Prof. KANSAL**
mlkfwt@iitr.ac.in

**Dr. Basanta Kumar Jena**
bkjena.niot@gov.in

**Dato' Ir. Haji Nor Hisham**
hisham@water.gov.my

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# International Association for Coastal Reservoir Research

**Registration Number: INC1700081**
**Date of Incorporation: 20 January 2017, issued by NSW Fair Trading, Australia under the Associations Incorporation Act 2009.**

**A paradigm shift from 'discharging floodwater' to 'storing and utilizing floodwater' by the coast.**

## ABOUT

IACRR was founded in January 2017 in Australia. It is an international nonprofit organization set up to promote and develop Coastal Reservoirs (CR). IACRR welcomes members from various sectors such as engineers, scientists, researchers, industry players, suppliers, contractors, developers, water agencies, operators and decision makers.

CR is a paradigm shift in water resources development from storing water in inland dams to storing freshwater by the coast. This converts floodwater into valuable water resources closer to the demand centres. IACRR will be the platform for sharing of knowledge and experience to ensure successful implementation of CR worldwide.

## VISION

Solving water shortage issues in major cities worldwide.

To be the world's leading organization, dedicated to advancing all aspects of CR and promoting the sustainable development and management of surface water otherwise lost to the sea.

## MISSION

Initiation of CR by leading the profession in setting standards and guidelines to ensure that CR is built and operated safely, efficiently, economically, and are environmentally sustainable and socially beneficial.

Assisting coastal cities to meet their water challenges using CR by optimizing its design, successful construction and management, maximizing the output and minimizing the negative impacts on environment and society;

Inspiring coastal cities' development by integrating its water resources with land resources and manpower resources, hence enhancing the world's living standard and reduce global poverty.

**International Association for Coastal Reservoir Research**
School of Civil, Mining and Environmental Engineering
University of Wollongong, Northfields Avenue, NSW 2522, Australia
http://iacrr.org | iacrr.org@gmail.com | Ph: +61-2-42213070