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IACRR CONNECT

Volume 2 | Issue 1 | 2018

Message from the President

Prof. T G SITHARAM,
President, IACRR

Dear IACRR members, Colleagues and Friends,

It is with great pleasure that I write this message for the IACRR Connect – **Issue 2** as President of the International Association for Coastal Reservoir (IACRR), having served with the association as Founder president since August, 2017. An impressive list of milestones and activities achieved during the last 3 months, for which I sincerely thank the management committee members of IACRR, IACRR secretariat as well as the IACRR members and partners. Special thanks to our secretariat, to Prof. Shuqing Yang of the University of Wollongong, NSW, Australia and Mr. Sin Poh Lim from Kuala Lumpur, Malaysia.

IACRR was inaugurated on the 16th of August, 2017 at Kuala Lumpur, Malaysia along the side of IAHR world congress. I would like to thank Dr. B R Shetty, Chief Patron, all my Vice presidents, secretaries and other office bearers, Mr. Kushal Shetty, Dr. Sreevalsa and other friends for making the world launching event very successful and colourful. The first newsletter – IACRR connect was released on the same day. Since then, IACRR has been a strong advocate of contributing sound scientific knowledge to policy formulation in identifying water resources, in particular on Coastal reservoirs. The Malaysian Water minister has announced that Malaysia will build coastal reservoirs as against land based reservoirs to store and capture river flood waters. IACRR has made significant efforts in conducting two special sessions- one in the 37th IAHR World Congress, Kuala Lumpur, Malaysia on 13-18th August, 2017 and one in the 7th IWA-ASPIRE Conference and Exhibition, 2017 at Kuala Lumpur, Malaysia from September 11 to 14, 2017. In IAHR 2017, during a special session on Coastal Reservoirs, 14 papers have been presented by authors from more than 8 countries. In IWA-ASPIRE conference event, 4 papers have been presented on coastal reservoirs.

> *"Coastal reservoirs will play a major role in ensuring both drinking water and better sanitation around the area, in particular in the developing countries. The newly approved UN Sustainable development goals has seen partial success, while focussing on water as a cross cutting axis for development."*

In addition, the team executed and submitted a report on "Feasibility studies on creation of a coastal reservoir in Mangalore near river Netravati" to Bangalore Water Supply and Sewerage Board (BWSSB) in the month of September, 2017. Several project proposals have

been submitted by the team India to raise awareness and research activities. A joint proposal has been submitted for Global Challenges Research Fund (GCRF) Networking Grants by the British Academy, the Royal Academy of Engineering and the Royal Society in collaboration with Prof. Roger Falconer, VP of IACRR on Coastal reservoir. A special issue on coastal reservoir has been brought out in the Journal of Sustainable Urbanization, Planning and Progress (JUSPP) from UDS publishing house, China with Prof. Shuqing Yang as a guest editor. This issue on Coastal reservoir is already online at http://ojs.udspub.com/index.php/jsupp/search?subject=coastal%20reservoir. Hard copy has been printed and released. A special issue on coastal reservoir is being planned in HYDROLINK – an official newsletter of IAHR in February, 2018. HydroLink is the primary magazine of the IAHR community and brings you the latest news in the world of hydro-environment engineering and research, edited by Dr. Angelos N. Findikakis. Articles are being prepared by the selected international authors and thanks to Prof. Roger Falconer, VP of IACRR for his effort towards this special issue in HYDROLINK. Another special issue is being worked out in the Journal of Sustainable Urbanization, Planning and Progress on coastal reservoirs design, planning and implementation. An annual general body meeting is being planned at Wollongong during January 23-25, 2018; along with an International workshop on coastal reservoirs. Speakers and event details are provided in the newsletter. I request all the members of IACRR to attend the AGM and the workshop in big numbers.

IACRR will be a strong advocate of contributing sound scientific knowledge and being the technology driver for the creation of coastal reservoirs, in addition to policy formulation. The focus is on- Water resource augmentation using coastal reservoir to capture river flood waters with sustainable water storage. In addition, around the coastal reservoir, new development along with the new economy and overall development of the area is expected to take place around this fresh water body with a sustainable growth in the energy sector, fisheries including deep water fishing, sand dredging for construction industry, etc. This is in tune with the United Nations millennium development goals, which highlights the improvement needed on safe drinking water along with improved sanitation. Coastal reservoirs will play a major role in ensuring both drinking water and better sanitation around the area, in particular in the developing countries. The newly approved UN Sustainable development goals has seen partial success, while focussing on water as a cross cutting axis for development. Thus, it is important to canvas for coastal reservoirs, which would be one of the cheapest and best solutions for solving the water shortage in this world.

I would like to report that there is good interest shown from members to take up IACRR's membership. However, we still have significant challenge to grow this membership and collect fees for the activities of IACRR. There is a need for assuring geographic diversity along with the formation of committees to handle diversified areas of research related to water, energy, sand, land development, environmental issues, etc. Three national chapters have been constituted and started their activities.

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Presently, there are 3 national chapters of IACRR started functioning in this span of 4 months. Australia chapter is functioning from University of Wollongong, NSW, Australia (will be inaugurated on 25th Jan 2018); Malaysia Chapter is functioning from Kaula Lumpur and India Chapter from Suratkal, Mangalore district, Karnataka. China, Hongkong and Bangladesh are considering the possibility of creating country chapters of IACRR.

The current situation provides a real opportunity for the IACRR as water storage is the prime activity and it is necessary to build a strong platform and make notable contributions to water storage around the world and in turn water management for a sustainable growth. I request the management committee and office bearers to put in extra effort to

get new corporate members for IACRR and also carry out a large number of technical activities across the world. This is very crucial to develop the association and our work will definitely reach out and create new coastal reservoir for our future generation. Finally, I will call upon all the office bearers and members to go out and increase the members for the society, reach out to new student members across different disciplines who will be the water experts of the future looking for coastal reservoirs as reservoirs for the future generations. I ask all of you to increase the student membership for the society.

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. See you all in Wollongong during Jan 24-25, 2018. Happy New Year greetings - 2018 to you all.

Prof Thallak G Sitharam
President, IACRR

Glimpse of launching of IACRR

The official launch of the IACRR was held at Seri Pacific Hotel, Kuala Lumpur, Malaysia on 16th August, 2017 (Wednesday) from 2 pm to 6 pm. The event was attended by numerous participants from all over the world, including the UK, the UAE, China, India, Netherland, Australia, Taiwan, Myanmar and Malaysia. The attendees included scientists, lecturers, engineers, hydrologists, contractors, suppliers, developers and other diverse professional fields. The IACRR also revealed and launched its official website: www.iacrr.org and released its first Newsletter.

Among the guests of honour and presenters were:-

- Dr. B R Shetty, the Chief Patron of IACRR;

(Chairman and Managing Director of NMC and Chairman of the UAE Exchange, Abu Dhabi, UAE),

- Prof. T G Sitharam, Founder and President of the IACRR, Chair Professor, at the Indian Institute of Science.
- Mr. Kushal Shetty, the Chairman of theIACRR India Chapter.
- Dr. C R Parthasarathy, Vice Chairman of the IACRR India Chapter and Founder of Sarathy Geotech & Engineering Services Pvt Ltd India.
- Prof. Roger A. Falconer, Vice President of the IACRR, Fellow of the Royal Academy of Engineering, UK.
- Associate Prof. Yang ShuQing, Co-Founder of the IACRR from the University of Wollongong, Australia.
- Dr Prahlada Ramarao, former distinguished scientist & DD R&D DRDO, former Vice Chancellor, DIAT(DU), DRDO, Ministry of Defence, Government of India
- Dr. Sreevalsa Kolathayar, Amrita University of India.
- Mr. Jinquan Wu from CCCC First Harbour Consultants Co. Ltd, China
- Datuk Lawrence Low, representative to Datuk Seri Ir. Dr. Wee Ka Seong, Minister in the Prime Minister's Dept.
- Dato' Ir Lim Chow Hock, Advisor of APEC/ International PE Registers and the ASEAN Federation of Engineering Organisations (AFEO),Chairman of the Malaysian Capacity Development Network for Water Resources Management (MyCDNet), a Board Member of

The 1st Board Meeting of IACRR was convened at Seri Pacific Hotel, Kuala Lumpur, Malaysia.

UNDP Cap-Net.

- Ir. Tan Yean Chin, President of the Institution of Engineers Malaysia (IEM)
- Mr. Win Naing Tun and Mr. Zaw Naing Oo from Resource & Environment Myanmar Co. Ltd
- Mr. Gauss Chen from CECI Engineering Consultants, Taiwan

President Prof. Sitharam started the event with the welcome address. As founder and President of IACRR, he welcomed everyone for this official launching of IACRR. He stressed on the concept of CR which will lead to new beginnings in Water Management.

Vice President Prof. Roger Falconer continued with a presentation highlighting the potential of CR by presenting a success story of urban regeneration project of Cardiff Bay.

Chief Patron and Guest of Honour, Dr. B. R. Shetty provided his opening remark followed by special guest Dr. Prahlada Ramarao. He highlighted the importance to have Water-Energy Nexus.

Aerial Hoop performance by Dr. Soxi Lee

Connaught Secondary School Choir Team

The event reached the peak with the arrival of Datuk Lawrence Low, the representative of Minister of Prime Minister's Dept., Malaysia – Y.BhgDatuk Seri Ir. Dr. Wee KaSiongwho officially launched the event.

Acknowledgement to Mr. Kushal Shetty (IACRR Indian Chapter Chairman) for his inspiring talk, dancer Dr. Soxi Lee with her aesthetic and the wonderful aerial hoop performance, and fantastic performance from Connaught Secondary School Choir team, and more importantly all the participants who made this official launching a success. The event ended with a presentation by the Co-Founder, Prof. Yang Shu Qing on Introduction to CR and international experiences.

A special thank you to all the Committee Members and team members for their great effort and dedication for making things run smoothly and help to make this event a successful and memorable one.

Message from the Chairman of Malaysia Chapter

Dato' Andy Choong
Chairman of Malaysia Chapter

Rivers play an important role in our lives. For thousands of years, civilisation at its earliest agrarian form was situated beside; and drawing sustenance from the river as in the case of the Tigris, the Euphrates, the Nile and the Yangtze. The rivers give the inhabitants a reliable source of water for drinking, washing and agriculture. Rivers also provide mankind with other additional benefits such as a source for fishery, a means for transportation, hydropower generation, recreation as well as providing fertile soil to the river plains. But the flow in a river is normally not constant and can vary greatly throughout the year. When there is too much water in the river due to heavy rain, flooding will occur. However, when there is too little water due to drought, water shortage will occur, resulting in water rationing. These two extreme water issues arise because of minimal or poor management of the water resources where thousands of gallons of water in the river has been left untapped and run directly into the ocean every year.

Malaysia is no exception for such river water issues because West Malaysia is a peninsula and there are many rivers running across the land. Sabah and Sarawak in the Borneo Island are faced with the same problems due to some major rivers which run right across the land to its coastal areas.

Many environmentalist and scientific groups or institutions have come together to explore for a much workable permanent solution. Hence, the mission of our innovative concept, 'coastal reservoir' is to store the rain or river water for solving those said problems and to provide water for human consumption such as domestic and industrial use, mining, agriculture, fisheries as well as recreational and environmental needs.

In Malaysia, we have been relying on the upper catchments of the rivers for our water resources which can only trap around5% to 15% of the annual rainfall at best. This approach is not feasible anymore because of the ever increasing water demand, due to the increase in population and national socio-economic growth. We've no choice but to go downstream up to the coastal areas to trap the river water.

In Malaysia, about 70% of the 496 billion cubic metre of surface runoff, or river flow, is lost to the sea as flood flows. Of the remaining 30%, half cannot be used because of saline intrusion. This means that only 15% of the surface runoff can be used. This 15% is what we term 'effective rainfall'. In other words, about 85% of the surface runoff in Malaysia is coming downstream and we just let it go totally out to the sea.

Hence, there is dire need for Malaysia to consider the concept of total water catchment from the source right up to the sea, and not just the upper stream forested areas. And along with this concept, the time has come to recognise the need for the implementation of coastal reservoirs along the river mouths.

In Peninsula Malaysia, there are big rivers such as Sungai Perak (390km), Sungai Selangor (80km), and Sungai Muar (190km) which drain into the Straits of Malacca; and Sungai Kelantan(250km) and Sungai Pahang (500km) which drain into the South China Sea.

In the state of Sabah, there is the Sungai Kinabatangan(560km) that stretches from the mountains of Southwest Sabah to its outlet at the Sulu Sea east of Sandakan; whereas in the state of Sarawak, the Rajang river (563km) flows across the northwest of Borneo.

Floods are regular natural disasters which happen in Malaysia nearly every year during the monsoon seasons. The recent2017 flood in Penang is a bitter lesson for the nation. Given Malaysia's geographical location, most floods that occur are a natural result of cyclical monsoons during the local tropical wet season, that are characterised by heavy rainfall from roughly October to March.

In order to solve the problems of both flooding and water shortage in Malaysia, we can make use

of the coastal reservoirs to contain the discharged flood water for future usage. To ensure the smooth development of the coastal reservoir projects, we need to seek the support from the following:

1. The Malaysian Government to enact a by-law to ensure the legitimacy of the concept and support for the acquisition of land /sea territory for the construction, monitoring and protection of the coastal reservoirs and their operations.

2. The Malaysian Government needs to pool funds from both the government and private sectors to enable the construction and operations of the coastal reservoirs.

3. The Government must recognise the professional body such as the Malaysia Chapter of the IACRR to provide the expertise and technical support, and set up research centres at higher education institutions to carry out necessary applied research.

As to harness and obtain government support for the by-law on the coastal reservoir in Malaysia, there are various ministries involved, including the need to address any land matters. Hence, to make sure that such major task can be successful in Malaysia, there is a need for both the government and private sector to join forces and provide the necessary resources. As the concept of coastal reservoir is relatively new in Malaysia, we need to obtain international help and efforts to convince our policy makers on the viability and economic feasibility of implementing coastal reservoirs in Malaysia, which is the way forward for our national development.

I would like to take this opportunity to thank Prof. T G Sitharam, the president and founder of International Association for Coastal Reservoir Research (IACRR), for allowing us to form a chapter here in Malaysia as an affiliate member of the association. We look forward to the close collaboration and technical support from the IACRR and we have high hope for the successful implementation and popularization of the Coastal Reservoir in Malaysia.

Message from the Chairman of India Chapter

Kushal Shetty
Chairman of India Chapter

India Chapter was inaugurated on December 4th 2017 at Dayanand Sagar college of Engineering, Bengaluru. On behalf of my executive committee and the members of our chapter I wish a very happy new year to all the readers of IACRR connect and We will put our efforts to make a second generation coastal reservoir construction a reality in India. I am sure that future generation needs coastal reservoirs for sustainable water supply for agriculture, industrial and domestic purpose.

India Chapter of IACRR Committee

Patrons:
1. Prof. T. G Sitharam, President, IACRR
2. Dr. Prahlada Ramarao

Chairman:
Mr. Kushal Shetty

Vice Chairman:
1. Dr. Ramaraju H K
2. Dr. C Subba Rao
3. Dr. C. R. Parthasarathy

Secretaries:
1. Dr. H Ramesh
2. Dr. K Sreevalsa

Joint Secretaries:
1. Dr. B. Manu
2. Dr. Nasar T

Treasurer:
Dr. Raviraj Mulangi

The Secretariat of IACRR India Chapter would be at Suratkal, Mangalore (Dist), Karnataka, India.

Article

Coastal Reservoirs and their Potential for Energy Generation

by
Prof Roger A. Falconer
Vice President, IACRR

As highlighted in IACRR Connect Vol 1, Issue 1, the world faces considerable water management challenges now and increasingly in the future. This is primarily brought about by: the anticipated impacts of climate change, the increasing need to provide more water, food and energy for a growing global population, and the increasing globalisation and urbanisation. However, not only does the world face considerable challenges of water management, it also faces a growing demand for more green renewable energy. In addition to the opportunities

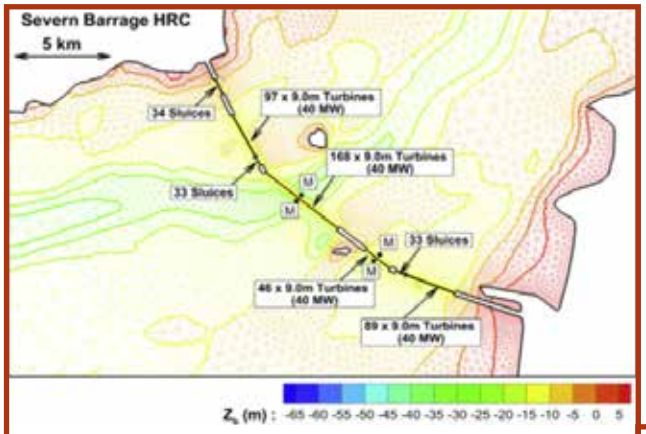


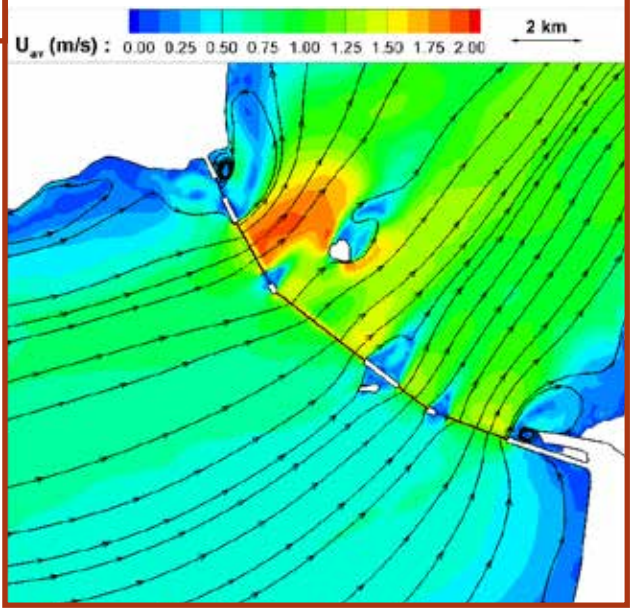
Figure 1 Schematic illustration of the Severn Barrage across the mouth of the Severn Estuary, based on a design concept considered by the Hydro-environmental Research Centre, at Cardiff University

offered by the Coastal Reservoirs as an attractive source of freshwater supply, without the need for desalination etc; such reservoirs can also offer considerable opportunities for energy supply and urban city regeneration. In recent years, the UK has focused much attention on generating tidal renewable energy from coastal reservoirs, in the form of barrages and tidal lagoons.

Considerable research, design and planning has been undertaken for both types of schemes, where a barrage will be assumed herein to create a coastal reservoir by spanning the estuary or embayment completely; whereas a tidal lagoon consists of a coastal reservoir connected to the estuary shoreline, but not spanning the estuarine basin. The South West region of the UK, including the large estuarine basin of the Bristol Channel and the Severn Estuary, experiences the second highest tidal range in the world and peaking at around 15.4m at the Port of Avon mouth, near Bristol. Hence, this water basin has attracted the attention and interest of engineers and scientists for over a century in terms of trying to develop the exceptional tidal resource for energy generation. Two such examples will be summarised briefly here, where coastal reservoirs have been, and continue to be, considered for energy generation, as well as urban regeneration. These include: (i) the Severn Barrage project, proposed in various forms over the past 50 years, and (ii) Swansea Bay Lagoon, proposed as a Pathfinder Project, with other larger lagoons proposed for development at Cardiff, Newport, Bridgwater Bay, West Cumbria and Colwyn Bay, along the North Wales coast.

For the Severn Barrage project, the proposed scheme would involve developing one of the

Figure 2 Schematic illustration of the velocities in the vicinity of a barrage generated coastal reservoir at mean flood tide



world's largest tidal renewable energy projects by building a barrage across the mouth of the Severn Estuary and creating a coastal reservoir, stretching from the English coast to the Welsh coast. The most recent proposal in the scientific literature is based on research undertaken within the Hydro-environmental Research Centre at Cardiff University and involves an impounded coastal reservoir, of length 16km (Figure 1). The barrage wall would include 400 turbines of maximum diameter 9.0m and would include sluice gates with a working area of 16,000m2. The research findings show that two-way energy generation – not previously considered in much detail for barrage schemes – offers the opportunity to provide almost as much energy as ebb tide generation only, and could provide up to 8% of the UK's energy needs, with an annual energy output of nearly 20TWhr. The scheme would also reduce the peak disturbance to the grid, minimise many of the perceived hydro-environmental impacts and offer considerable reductions in flood risk upstream of the coastal reservoir wall. However, the water elevation would increase slightly on the downstream side for much of the Bristol Channel, marginally increasing the flood risk for some communities. The project would also reduce the large tidal currents to some degree (Figure 2), which will lead to some reductions in the suspended sediment load, increasing light penetration within the water column and increasing the diversity of sediment-dwelling organisms and other aquatic life in the estuary. The project also offers considerable opportunities for urban regeneration in the region.

For the Swansea Bay Lagoon pathfinder project, this is a relatively small (320MW installed capacity) coastaly attached lagoon, to be built in Swansea Bay along the Bristol Channel, and has been designed and promoted by Tidal Lagoon Plc. The lagoon, forming a coastal reservoir along the shoreline, has a bank of 16 tidal turbines and 8 sluice gates and would be the first of its kind to be constructed world-wide (Figure 3). Water fills up and empties the constructed reservoir as the tides rise and fall, with electricity being generated on both the incoming and outgoing tides, four times a day, every day. There is already a 4.3m peak height difference in water levels between the inside and the outside of the lagoon. Power is then generated as the water flows through the 7.2m diameter bi-directional bulb turbines. The project was awarded a Development Consent Order in 2015 and is currently primed for construction.

The 320MW pathfinder project provides a scalable blueprint for the company's programme of future coastal reservoirs for energy generation, with the fleet of larger UK and world-wide proposed tidal lagoons being designed to generate renewable electricity at a much larger scale and for a much reduced cost, relative to Swansea. Further information on these proposed future schemes can be found at: http://www.tidallagoonpower.com/. They include, for example: Cardiff – with a coastal reservoir 6 times bigger than Swansea Bay and with an energy output 9.6 times greater; and Gujarat, India - 3 lagoons with a power output of 16.5GW. Opportunities also exist for example in Korea – 3 lagoons with a power output of 7.5 GW, etc.:

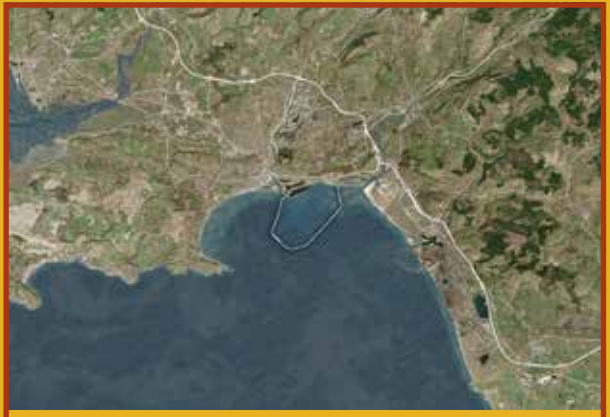


Figure 3 View of Swansea Bay Lagoon located in Swansea Bay (Picture courtesy of Tidal Lagoon Plc)

Figure 4 Artists impression of the coastal reservoir (or lagoon) wall highlighting the recreational opportunities afforded in completing energy generation (Picture courtesy of Tidal Lagoon Plc).

Article

IACRR's infancy and its lightening development

by
Shu-Qing Yang
Secretariat, IACRR

The Birth of IACRR

The story of the birth of IACRR and its infancy is sure to interest historians. Future generations who will drink water from the coastal reservoirs also have the rights to know the facts of today and how was that made possible. Naturally, every family member is very happy when they know about the arrival of a new baby. When I prepared IAHR's (International Association for Hydraulic Research) coastal reservoir session in early August, some bad news came from different sources. For example, someone could not attend IACRR's inauguration/CR session due to unreasonable causes, i.e., travel/visa applications were rejected. Even IACRR was not allowed to have its inauguration in the planned Seri Pacific Hotel. On the eve of IACRR's birthday, the key family members worried about the bad news, and asked again and again whether this baby is going to be abortive or alive?

The birthday (Aug. 16, 2017) was a sunny day, and the baby finally came out from the highly pressured womb with a bloody body, definitely aloud crying also accompanied by aloud songs from angels, much more aloud than the outdoor noise. About 100 family members surrounded the newborn baby and the baby is also accompanied by various angels. A thank you to them follows.

Thank you, Prof. Roger Falconer, you protect the baby from every aspect. When someone accused that IACRR is illegal, you fought back firmly with your unbelievable clear memory, so that they were never able to argue about IACRR's notable ID. You must be sent by our God for the righteous mission. Our future generations must remember your great contribution and know that without your firm support, IACRR might suffer its abortion on its birth day.

Thank you, Prof. T.G. Sitharam, for ensuring the safe birth of IACRR. For this, you said that you could step down or co-chair IACRR with someone we never knew. It seems like a mother prepares to sacrifice herself for her baby. Thanks to God, the baby is safe and your self-sacrificing spirit should be always remembered by our people.

Thank you, Ir Sinpoh Lim, Univ. of Wollongong's students still remember that in 2015 you drew a tree on a while board saying that "When a seed is sowed in soil at the right time and the right location, never ask for how much you can harvest, it depends on the depth of your roots, its soil and the water you give". This time we observed that you follow your words, and provided such a cosy environment for the new born baby. Your smile is always so sweet that no one has the heart to hurt your baby.

Thank you, Prof. Pengzhi Lim, from the very beginning you believe that CR technology is the solution to the world's water crisis. You introduced so many CR opportunities; like in 2006 to Shenzhen, China. This time again you suggested the special session to IAHR's KL world congress, you initiated Taiwan's CR development. You knew the baby's abortive risk better than anyone else, but you were calm to deal with every risk with your amazing diplomatic skills. Without you, IACRR would have been almost impossible.

Fig. 1, Happy birthday, IACRR. All of us promise to provide sufficient, high-quality and affordable water to the world (photo was taken by Prof. Yiping Li, Hohai Univ., China on Aug. 16, 2017)

Thank you, all 100 family members, you stood up so firmly and surrounded the baby so closely (see Fig. 1), no one had the chance to hurt your baby. The family members mainly came from Malaysia, China, India representing researchers, government decision-makers, consultant engineers and construction industry, and even royal families. One person specially flew to KL from Burma. Two members drove 400km from Johor state to KL just for the inauguration. It is a pity that the planned press conference was cancelled at the last minute because of big pressure that IACRR suffered.

It is a natural process that any new born baby may have his sickness and ordeals. Similarly for IACRR, it is predictable that his development may have many setbacks. But all founding members have promised to look after you, our God bless you, and these angels protect you, be brave little baby- IACRR.

IACRR in the infancy stage

This baby's birth immediately attracts water industry's attention. The second day after its inauguration, IACRR received an invitation from the Kedah state and its royal family who are interested in the CR technology. In a one-hour meeting, they were fully convinced that the CR technology is the feasible and sustainable solution, better than their previous solutions. They concluded that CR technology can protect the environment and it even has no negative impacts on the mangroves in its river mouth. Ir. Lim SP was asked to conduct a preliminary feasibility study for the government's further assessment. This is the first CR project contract in the 1st day after its birth.

Fig. 2 Malaysian CR team and Malaysian chapter leaders

In the 37th IAHR congress, CR special session received 17 papers, and more than 50 authors made this event successful. The authors came from China (50%), Australia, Inia, Malaysia and Egypt. The topics covered the design experience of Shanghai Qingcaosha coastal reservoir, Tianjin Caofeidian coastal reservoir, and even potential CRs in the Nile River Delta, Burma and India. Very impressively, a young and handsome engineer, Mr. Michael Teh gave a very good, clear and professional presentation that impressed all audiences, in which he clearly outlined the pros and cons of the existing water solutions, and highlighted that Malaysia only uses 2.7% of its runoff, but other solutions are based on water shortage assumption.

During Sept. 11-14, the 7th IWA-ASPIRE Conference was held in KL, a CR special session attracted 8 papers and thanks to JSUPP's support, all the papers were publish in http://ojs.udspub.com/index.php/jsupp/issue/view/51, and the significance of each paper is summarized in its editorial "Can floodwater in estuaries be developed as drinkable water without desalination?". During this event, the Malaysian chapter's leaders had a meeting and the chapter's chair, vice chair, treasure and secretariat were elected (see Fig. 2). Malaysia chapter highlighted the needs of coastal reservoirs in Johor State, Selangor State, Kedah state, Sabah state and Kelantan state. The last one now depends heavily on ground water by constructing underground dam to stop groundwater flowing to the sea. In the conference, Malaysia officially announced that all upstream reservoirs, desalination plants will not be considered, downstream reservoirs are now their national choice (see Fig. 3).

September turned to be a fruitful and lucky month for the newborn baby. Besides Malaysia, Bangladesh also expressed their great interest to construct coastal reservoirs to mitigate its flood disasters and also to provide sufficient freshwater. A local chapter is going to be established in Bangladesh (Fig. 4).

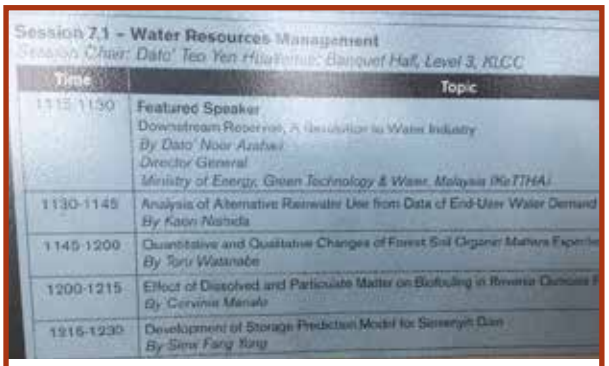


Fig. 3, Malaysia becomes the first country who abandons desalination and upstream reservoir development, but focuses on downstream storage.

Fig. 4, IACRR's President, Prof. Sitharam visited Bangladesh and a new chapter is going to open.

A meeting between Taiwan water leaders and IACRR's members was organized, and Taiwan expressed the interest using CR technology for its water crisis; and IACRR is committed to help Taiwan to achieve this goal.

A think tank of LNP, Queensland, Australia (shadow government) invited IACRR members attended this party's workshop on Saturday, the 23rd of September, 2017; held at the state Parliament House. These 30 attendees represented the Committee (Energy, Biofuels and Water Supply), and people also came from Environment, Infrastructure, Northern Development and Agriculture committees. It was surprising that the party members already knew how to design coastal reservoirs. A consensus was achieved

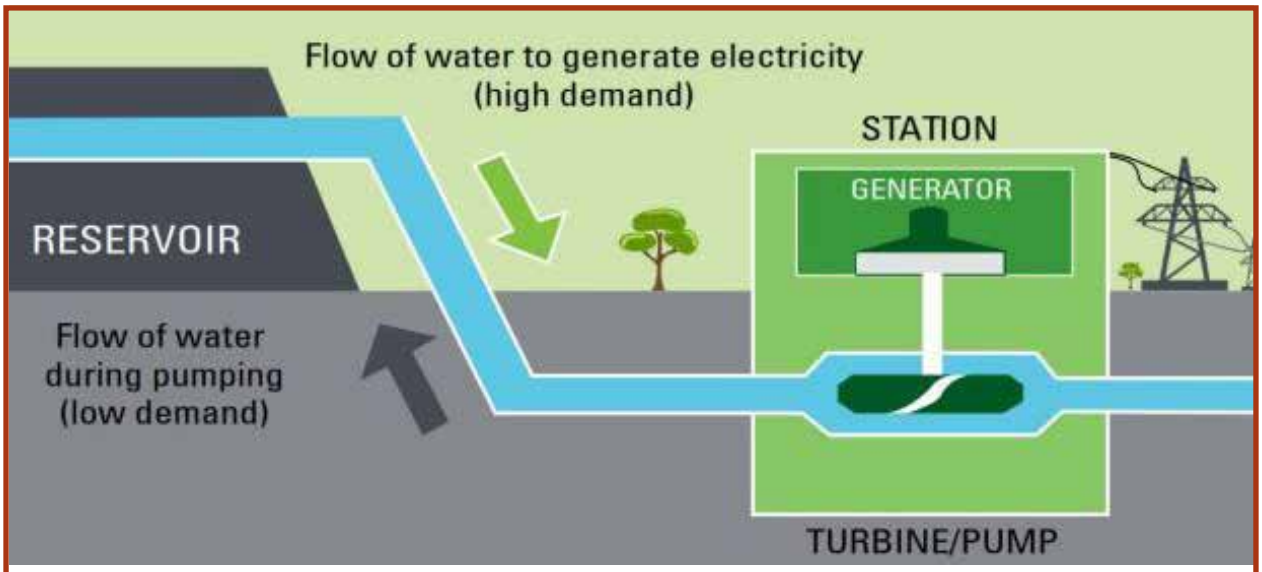


Fig. 5 Coastal Reservoir is used for power storage (Australian initial proposal is use seawater, IACRR may change it into freshwater reservoir to low the cost induced by seawater corrosion, even for dry states like South/West Australia).

that the coastal reservoir concept is sustainable and applicable for Queensland State. They also pointed out that it will be the party's police at right time (dry years). The committee commented that anything needs to have 5 'good', i.e., (a good idea, by a good party, at good time, in a good location and using a good way). The committee may recommend CR as the party's policy across the country as the Labour Party's (Queensland's government) wastewater recycling project (called as West Corridor Project) has resulted in big economical loss. Its initial cost was AU$2.6 billion, now the audit report showed the cost as A$14.9 billion. Half of the revenue that SEQ Water has to be used for the bank's interest caused by the project, despite the fact that not a single drop of water was produced by this huge project.

In October, IACRR's influence crossed the water supply boundary to power supply industry. The Malaysian team successfully attracted the power plants' attention and they invited IACRR to solve their water problems: everyday they need to buy a huge amount of tap water for steaming, and seawater for cooling (sometimes, the quality of seawater is not very good due to high turbidity). In dry seasons, they face the risk to be asked for reducing freshwater usage for electricity generation, huge cost will be induced once the government cannot supply sufficient freshwater. Now, they feel that IACRR can provide them sufficient and good quality water for their needs. Simultaneously, Australia is also discussing the feasibility to store energy in coastal reservoirs (http://www.smh.com.au/business/energy/new-study-shows-sea-could-be-sustainable-energy-source-20171002-gyt5uq.html), and the idea is shown in Fig. 5. Australia's initial proposal is to use seawater, IACRR feels that it could be improved by using freshwater reservoir to low the cost induced by the seawater corrosion. Federal Energy Minister Josh Frydenberg said the report was encouraging for further work on saltwater pumped hydro. Obviously, if IACRR involves in this project, the cost could be significantly reduced, and the project will be cleaner and more 'encouraging'.

Another milestone in IACRR's 2nd month was the setup of "Water Leaders Committee". It is our great honor that the deputy general secretariat from Kettah (Ministry of Energy, Green Technology and Water, Malaysia), Dr. Yew Chong Tan accepted our invitation as the founding Chair. We know that wars were for yellow gold before 1900, then black gold thereafter, and blue gold for future. IACRR will have big impacts on inter-government water issues that exist always at different levels. The administrative barrier almost caused IACRR's abortion in August, and it will exist in future for any CR projects. Shanghai and Singapore's experience is to merge different water-related departments under one roof. But innovative modes are needed for trans-boundary water disputes like Karnataka and Tamil Nadu in India for Cauvery River, even India and Bangladesh over Ganga River. As water is a universal solvent able to dissolve everything including political disputes over water itself; and also water can bond everything together. It is therefore expected that the committee can unite all communities, departments and inter-governments like 'cement' using the powerful water's 'cohesion and adhesion' properties. By doing so, IACRR's this committee headed by Dr. Tan could be a future Nobel Peace Prize winner.

Compared with other water associations/organizations, IACRR is developing much faster than all of them, and the possible reasons are summarized in Table 1. But it is the outcome of all founding members' great effort. Next step, we have to transplant our ideas/concepts to every coastal city and we need every member's contribution to construct CRs everywhere around the world.

Table 1. Difference between IACRR and other water associations

Other groups & associations	IACRR
No enough water	Sufficient for man's need
Floodwater cannot be developed	Floodwater is also our water resources
Dam can be only constructed in freshwater environment.	Dam can be also constructed in seawater environment.
High environmental/social impacts	CR has minimum impacts
Enclosed group for problems	Open system, value your contribution.
Without project involvement Keep talking about water/climate change problems	With project involvement Focus on water solution

Article

CR Developments in Malaysia, Australia and Taiwan

Malaysia

FORMATION OF IACRR MALAYSIA CHAPTER

The IACRR Malaysia Chapter was formed on the 12th of September, 2017 at Kuala Lumpur and the first meeting was held on the same day at Kuala Lumpur Convention Centre. The following persons were voted and appointed as members of the Executive Committee:

Chairman :YBhg. Dato' Andy ChoongKar Foo
Deputy of Chairman :YBhg. Dato' Ir. Lim Chow Hock
Secretary : Ms Nadzirah Binti Nazarudin
The Vice Chairman 1, 2 and 3 and the Treasurer are yet to be appointed.

The General Committee Members are Ir. Leong ChoonKee, Ir. TinoOo Gin Pheng and Dr. Low Kwai Sim. Also present at the meeting were The Secretary of IACRR, Prof. Shuqing Yang and the Joint Secretary, Ir Lim Sim Poh.Asa IACRR Malaysia Chapter, it will start off with registering with the Register of Society. It was also agreed that the Malaysia Chapter will hold its meeting once in every two months.

Australia

CR DEVELOPMENT IN AUSTRALIA

Both Australia and Netherlands have the credit to construct the earliest coastal reservoirs in the world. In 1930s, a coastal reservoir was created at the Murray-Darling river mouth by constructing 5 barrages at the outlets of the Lake Alexandrina (Fig. 1). Murray-Darling River is one of the largest river in the world in terms of catchment area which is similar to Indian Ganga River. Before 1930s, the lake water was fresh/brackish intermittently. During extreme droughts, the seawater intrusion could reach 250km upstream along the river course, which had disastrous results for the agricultural irrigation and other purposes. This is why the 680km2 lake is being changed into a coastal reservoir for freshwater storage (see Fig. 1). These barrages can also stabilize the river level for irrigation and to scour a channel for navigation. At full supply, the lakes hold approximately 1740GL. Estimates of evaporation vary, but the lakes probably require 700-950GL to maintain their normal level. When the flow exceeds this volume, it is released to the Murray Estuary and flows into the Coorong North Lagoon or out the Murray Mouth. During the recent drought (2000-2010), the lake's salinity was increased to 6200EC due to high evaporation (800EC is the upper limit for drinking purpose), thus its CR design is not perfect. This is an example that the first generation CR may have water quality problems caused by the non-point source pollution and evaporation.

The problem has been solved by the second generation CR whose design is shown in Fig. 1 (right), where the red line is the reservoir's dike, its enclosed area is 150km2 with storage 580GL. The feasibility was investigated by the world's first PhD thesis in CR, completed in 2017 by Dr. Jianli Liu, whose PhD thesis topic is 'Hydrodynamic and Salinity Simulation in the Lower Lakes, South Australia and Proposed Coastal Reservoir'. Her research result indicates that Adelaide's water supply can be secured once the proposed CR is constructed, similar to the Hoover dam for Las Vegas, another mega city in desert.

Australian government has also tried other water solutions. In 2008, a wastewater recycling system

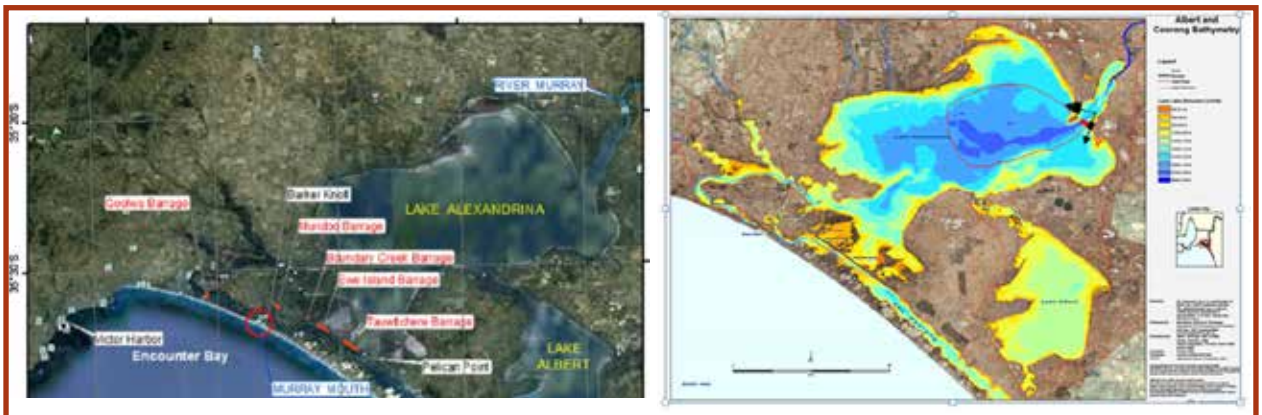


Fig. 1 the first generation CR (left), and proposed second generation CR (right) in the Lake Alexandrina (thin red line = dike; red block = gate that is open when high quality water appears in flood seasons; otherwise the excessive river water enters the lake via the black gates).

was constructed in Brisbane at the cost of A$2.7 billion, and now it turned out to be A$14.9 billion after its general audit. The West Corridor Project was shut down due to the government's 'tragic error judgement'. Likewise, other capital cities like Sydney and Melbourne constructed desalination plants based on the assumption of water shortage. The A$2.6 billion Melbourne plant, was found in a recent audit that the total cost in 30 years will be A$19 billion, even without producing a single drop of water. Thus, many politicians and tax payers have begun to describe it as a 'white elephant'.

On June 6, 2017, the University of Wollongong launched the inauguration of the Center for Coastal Reservoir Research (CCRR). The members covered water resources engineering, water quality engineering, geotechnical, coastal engineering, numerical simulation, real time measurement structural engineering, maritime law and financial analysis etc.

On September 23, 2017, LNP Queensland had a workshop for this shadow government's future policy in election. It is concluded that CR is a good solution for Queensland and even Australia. It is agreed that the proposed CR at Brisbane river mouth can mitigate/ eliminate flood disasters like 2011 and develop its water resources simultaneously. The party's elites agree that Australia is not running out of water, but water is running out of Australia (Fig. 2).

University of Wollongong is going to organize a CR workshop during January 24-25, 2018. Its theme is "Innovative solutions to UN's Sustainable Development Goal 6". It is expected that 100 delegates may attend this workshop. This is a platform for CR experts, potential consultants, contractors, developers and water leaders to discuss the feasibility of CR's application for each city's water supply.

Fig. 2 Queensland's shadow government's party member discussed coastal reservoirs in its workshop on Sept. 23, 2018.

Taiwan

CR DEVELOPMENT IN TAIWAN

On September 12, 2017, the 7th IWA-ASPIRE organizer, Dr. Yew Chong Tan arranged a meeting between IACRR and the water leaders from Taiwan, including the Deputy Director-General of Water Resources Agency Hua-Ping Tsao, President of Tainan Water Corporation Nan-Tzer Hu, Deputy Commissioner of Taibei Water Dept. Man-li Chen, Vice President of Nantional United Univ. Prof. Wen-Cheng Liu, Vice president of National Taiwan Univ. (NTU) Prof. Gen-Shuh Wang, Distinguish professor Shang-Lien Lo (NTU); Distinguish Prof. of

National Cheng Kung Univ. (NCKU) Liang-Ming Whang, and NCKU's Distinguish professor Tsair-Fuh Lin. Both sides had a vivid discussion about Taiwan's water crisis and the conclusions are briefly stated below:

1) Taiwan is important to IACRR as it is an earthquake active island with high population density in the coast. Its inland region is not suitable for large scale dam development as all the rivers are short and steep. If CR is successful in Taiwan, other similar places may refer to Taiwan as an example.

2) Taiwan Island covers 35,883 km^2, and receives 2.5m of rainfall annually. The estimated annual runoff to the sea is about 55km^3/year, and its water usage is about 16km^3/year, or less than 30% of runoff. So, Taiwan is not running out of water but water is running out of Taiwan.

3) Taiwan examined the feasibility of 1st generation CR, and concluded that CR technology is not feasible as the river water in Taiwan is heavily polluted.

4) IACRR is going to help Taiwan to develop the 2nd generation CR. The target is to provide Taiwan with sufficient and high quality water with minimum environmental/social impacts.

Fig. 1 proposed coastal reservoir for Taibei to develop 4.77km^3/year runoff from Tamsui River to mitigate flood and drought disasters.

In October, IACRR received Prof. Shih-Chun Hsiao's requests about Taiwan's CR development. He said that they are asked to collect some information and see if there is a chance to develop CR for Taiwan, and a report will be submitted in 2019. Under this request, IACRR contributes a preliminary CR design for Taibei, its capital city as follows.

Article

A brief overview of The Gulf of Khambhat Development Project (Kalpasar), Gujarat

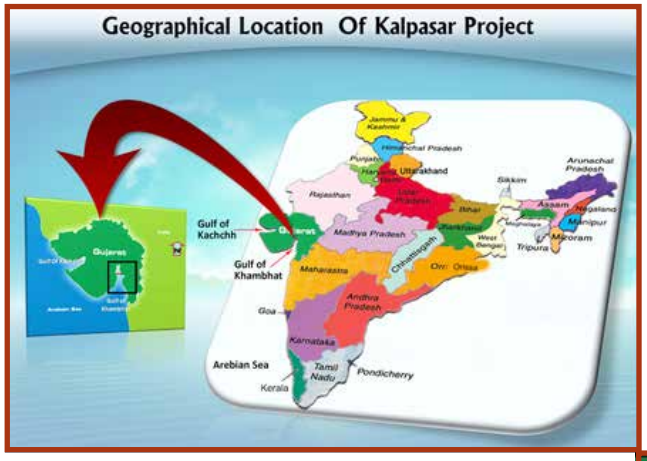
by
Dr. Sreevalsa K,
Secretary of India Chapter of IACRR

"Water water everywhere, but no water to drink!!" is the condition of our country presently. In spite of having many number of rivers, India faces acute water shortage, especially during summer. Many environmentalists would claim the population and pollution as the important factor for this scenario. But the actual reality is that there haven't been many variations in the average annual rainfall that India have been receiving for the past 200 years. So, we need to think optimistically how to store the water that we receive as rainfall. Inland reservoirs have their own disadvantages, as it causes a lot of law and order problems which includes the displacement of people and the submergence of forests etc. In addition, the lifespan of a dam would be between 100 to 150 years and their storage capacity is reduced by the process of siltation.

Focusing on the state of Gujarat, it is listed as the highwater-stressed states among the various states in India. It has around 63 rivers and around 600 large and small dams constructed. Thus, the Kalpasar project proposed at the Gulf of Khambhat at Gujarat not only addresses all the disadvantages that a regular inland reservoir has, but also can solve the water crisis that is prevailing in the state.

It is based on the innovative concept of storing fresh water without any damage to the ecosystem and to the population. The project envisages to create the world's largest fresh water reservoir in sea, by constructing a 30 km long dam in the gulf of Khambhat, to store more than 10,000 MCM of surface water, ie. 25% of volume of state's average annual rain water inflow. Kalpasar aims to collect the runoff water from Sabarmathi, Dhadar, Mahisagar and Narmada rivers to utilize it for irrigation, industrial and drinking purpose.

In the Gulf of Khambhat, grasped by the Gujarat fundamental land and the eastern shoreline of Saurashtra promontory, yearly a volume of more than 30,000 Mm3 of waters streams away, before it



can be utilized to relieve the extreme lack of drinking and water system water in Gujarat, particularly in the Saurashtra landmass. The Gulf of Khambhat Project or Kalpasar Project goes for the making of a new water supply in the Gulf of Khambhat, by the development of a dam interfacing the east and west bank of the Gulf. In the supply, the spillover from Sabarmati, Mahi, Dhadar and Narmada will be put away, together with the waters from the Saurashtra streams releasing into the Gulf of Khambhat. The put away waters are to be utilized for water system, water supply and mechanical necessities in the Saurashtra district.

Working with the mission of making Gujarat, a Sustainable water state, with "Water for all, Water forever, More crop per drop". Kalpasar is not just a solution for the water problems but it has additional benefits as well. This coastal dam once completed will serve as a wonderful 10 lane road connecting Saurashtra and South Gujarat ie, between Bhavnagar and Surat, which would save time and fuel expense of the public, who otherwise use long route. This would also serve as a key for the development of those cities that are being connected by Kalpasar both economically and socially. This would stand as the example for the sustainability, as they have the set up to store and utilize the renewable resources such as tidal energy, wind energy, and solar energy. Apart from this, it has various benefits in various other fields also, namely, Land reclamation, Fisheries, reduction in salinity, Port development, Tourism development etc. One more striking feature is the Return On Investment (ROI) of this structure. This structure turns to be profitable after 10 years, which cannot be provided by any inland reservoirs.

The Kalpasar Project is viewed as the clear answer for illuminating on the short and also on the long haul the undermining drinking and water system water issues in Saurashtra. The Kalpasar Project is viewed as the clear answer for illuminating on both the short and also on the long haul the undermining drinking and water system water issues in Saurashtra. Once the Gulf is shut, water levels inside the repository can be controlled, while the tidal vacillation outside the supply proceeds and, henceforth, can be saddled for the age of tidal vitality. It is estimated that the transition of salt water to target salinity of 0.1% will take four years, when the transformation from salt water bay to fresh water reservoir starts.

The Kalpasar venture, if actualized with commitment and without debasement, will resolve four crucial issues of the State of Gujarat which are water, electrical power, street rail transport and improvement of ports. As the name suggests, this lake will have the capacity to fulfill our wishes making Gujarat a state with abundant Water, accelerating its development journey.

Article

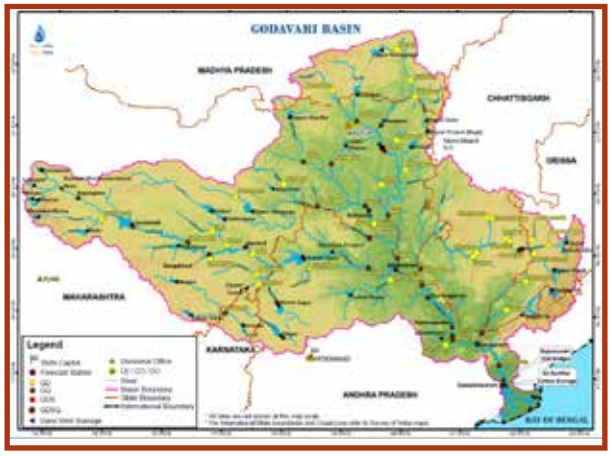
Godavari Flood Waters –A treasure trove for Andhra Pradesh

by
Prof. R Subba Rao and Dr. Sreevalsa K

India is blessed with an abundant amount of rainfall but its improper storage has resulted in the country facing extremely high water stress levels. The lack of water has caused many problems in the country. Linking of rivers through pipes has become a dream because of the land acquisition issues and numerous environmental effects like deforestation and soil-erosion, and social unrest due to the displacement of large number of people. The problems which arise due to the scarcity of water can be solved by building a sea based reservoir at the mouth of the river, which impounds the excess of flood waters during the monsoon season. These flood waters would also act as a source of fresh water. Therefore, this would be an innovative and sustainable approach to meet the growing demands of water in the country.

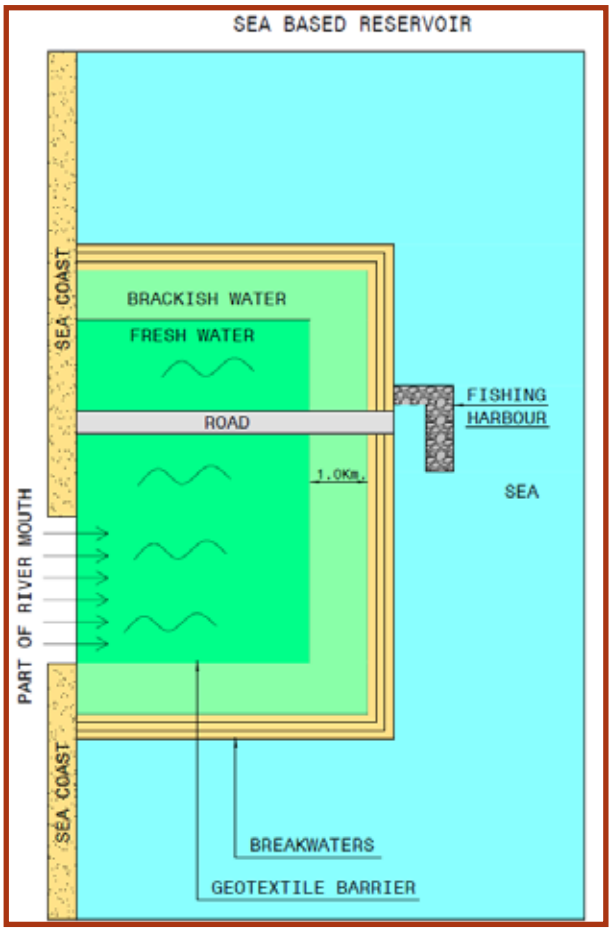
Godavari River, which is 1465Km long passes through 5 states with a catchment area of 312812 (sq. Km). The average annual rainfall that the region receives is from 1000 – 3000mm. The run-off water from the Godavari River amounts to be more than 3000 TMCft and a part of it can be impounded by building a coastal reservoir.

The land based reservoir has many disadvantages like greater use of land, materials to build it and large displacement of people which is impossible in the current situation. The other major disadvantage of this type of reservoir is its lifetime and its constant loading activity which can result in seismic problems to the surrounding location. On the other hand, sea- based reservoir has many social and environmental benefits. It would also act as a means to generate wealth for many people, thereby the economic prosperity of the country rises. The sea based reservoir mainly aims at storing the fresh water, which can be directly sent for the usage purpose of the people. The mixing of fresh water from sea water is prevented by building geotextile membrane as inner wall and break waters as the outer wall. The geotextile membrane will prevent the salt water intrusion into the fresh water. The brackish water would prevent the high tides of sea water entering into the fresh water storage. There would be facilities for harbour and fishing which would not affect the coastal livelihood of people. Roads can also be built on the reservoir for tourist and transportation purposes.



A sea based reservoir near Godavari basin in Andhra Pradesh will cater to the growing needs of people in this state and the nearby states. This sea based reservoir can store up to 100 TMC of water with suitable dimensions depending on the bathymetric profile of the region. The approximate reservoir size would be 12m deep at far end, 6.6 Km wide and 26.4 m long to store 35 TMC. The project can be planned to be owned, built and operated by a private investor under the water purchase agreement with the Tamil Nadu and the Andhra Pradesh government. The approximate water cost would be Rs.35/kL that includes the Interest cost, Annual pay back cost, Maintenance cost, power and transportation cost. Before the construction of this project, a comprehensive feasibility study must be done. It would include the multifaceted approach of the project. The existing and future demands of the people around the region would be analysed. Hydrological analysis of the Godavari River and its pre-feasibility survey would be done for the cross section and the longitudinal section of the river. Further analysis would be done on the Dyke

construction methods and its materials to impound flood waters. As the structure would be built near the coast, its social and environmental effects need to be considered and addressed. The coastal livelihoods of the people and the water quality parameters would be evaluated and analysed. It is not only the storage but the transportation of water which has to be analysed during the cost consideration of the project. The total project cost would be up to Rs.5004 crores which includes the cost of break water, excavation, transportation, trawlers, labour and maintenance, geotextile screens and pumping. The cost of pumping can be reduced in the upcoming years by using renewable sources of energy like Solar, Wind and Tidal energy. There are many other attractions to this reservoir which includes its aesthetic look, which would act as a tourist attraction. This would help both the people and the government in many ways. The capacity to store the water is huge without acquiring land and disturbing people and nature. Therefore, these types of sustainable projects can be scaled up through-out the country to meet the rising demands of the people. Assuming that we build a hypothetical reservoir to store 300 BCM of flood waters on the land, the size of such a reservoir would be 30, 000 square kilometers for water depth of 10 meters! The Coastal Reservoirs have the capacity to store more



water than all the land based reservoirs put together in India, without using a single cent of land and therefore zero land acquisition.

INTERNATIONAL ASSOCIATION FOR COASTAL RESERVOIR RESEARCH (IACRR)

25th Jan. 2018

Venue: University of Wollongong, Australia

ANNUAL GENERAL MEETING (GENERAL BODY)

AGENDA

Welcome by Shu-Qing Yang
IACRR's Report by IACRR's president, Prof. TG Sitharam
Speech by IACRR vice-president Prof. Roger Falconer
Speech by IACRR's vice president Prof. Jun Xia
Malaysia Chapter chair's report by Mr. Kushal Shetty
India Chapter chair's report by Mr. Andy Choong
Beijing Branch chair's report by Prof. Liu-Chao Qiu
Australia/New Zealand chapter chair's report by Prof. James Ball
Treasurer's financial report, Dr. Shishun Zhang
Conclusive Remarks by IACRR's President, Prof. TG Sitharam.

Visit to Bangladesh by President IACRR

Prof. T G Sitharam, President, IACRR visited Bangladesh University of Engineering and Technology (BUET), DHAKA at their JIDPUS campus for organizing a training course on 'Geophysical and Geotechnical characterization and applications to Civil Engineering', relevant to higher education Quality Improvement programme. He interacted with the senior faculty at BUET and also made a presentation on Coastal reservoir prospects to Bangladesh. Several senior Professors including Prof Tahmeed Al-Hussaini, Prof Mashfiqus Salehin were present at the meeting. Dr. Partha Sarathy, Vice Chairman, IACRR – India Chapter accompanied Prof. Sitharam to Dhaka.

Reaction about the course as given by Prof. Tahmeed Al-Husaaini, former head of JIDPUS is enclosed below:

Dear Prof. Sitharam:

Hope you had a safe journey back home. We really enjoyed the deliberations of you and your team, which were very resourceful. For the participants, it was a great learning experience on the variety of remarkable work done by your team. I would like to once again express our gratitude and appreciation for your time and efforts for making the training program so successful.

Attaching some photos for remembrance.

Best regards

Tahmeed

Dear Prof. Yang:

Thank you for your invitation to be associated with IACRR. I would like to consider having some involvement as a geotechnical and earthquake engineering professional.

We are thankful to Prof. Sitharam for introducing to us the concept of coastal reservoirs which may have the potential for far fetching benefits for Bangladesh.

Best regards

Tahmeed

Tahmeed M. Al-Hussaini,
Ph.D. (SUNY-Buffalo), M.Engg. (AIT)
Professor of Civil Engineering
Bangladesh University of Engineering & Technology

Future activities and Wollongong CR workshop

UoW is going to organize an International Workshop on Coastal Reservoirs (www.ccrr2018.com). The main purpose is to provide a feasible solution to SDG6 for the UN members. In 2015, members of the United Nations (UN) assessed the crisis that the humans face, and 17 Sustainable Development Goals have been endorsed by its 193 members. Among them, Goal 6- to provide "safe and affordable drinking water for all by 2030", is probably the most difficult or almost impossible to achieve. If there is no revolutionary new solution, or the new solution is not clearly presented to governments, because currently about 40% of the global population are being affected by water scarcity, and this percentage is only going to rise. A novel solution is thus urgently needed.

Urbanization is a process whereby more and more people are attracted to cities, especially coastal cities. For example, a coastal city with less than 1 million population in the late 1980s could be developed as a megacity in 30 years like Shenzhen, China, with a current population of 12 million. In the next 30 years, many coastal cities like Sydney may double their populations. Consequently, these coastal cities will face serious risk in water supply. In the Millennium Drought (2000-2009), Sydney's dam water was lowered to less than 30% of its full capacity. Water could be the biggest challenge for Sydney if a similar drought happened again. Although inland dams, wastewater recycling and desalination have served as urban water supply options, time has come to find more innovative and smart ways to quench the world's thirst.

By analysing the available data, we found that currently Australia only uses 5 or 6% of its runoff, similar to the rest of the world. We conclude that around the world, cities appear to be running out of water. In reality, it is the water that is running out of the cities. UoW developed a technology --coastal reservoirs (CR), whose dam is situated in seawater to recover floodwater entering the sea without desalination.

Now CR has become a world phenomenon. The international Association for Coastal Reservoir Research (IACRR) has been inaugurated. Malaysia, India, China, Bangladesh and Australia are organizing local chapters. Many governments have decided to concentrate on CR development for their water shortage.

This workshop will focus on the water challenges (SDG6) and will act as a platform to disseminate the most recent research and field advances to the engineering community. Presentations from leading experts, professionals, and industry specialists will showcase the technical advances and past experience related to Coastal Reservoirs. Invited lectures from world renowned experts in coastal reservoir infrastructure will add value to the technical skills of the professionals. The conference will act as a platform for the delegates to share the issues, ensure knowledge transfer and to learn the impact of emerging technologies. The topics will be focussed on the coastal reservoir infrastructure: water availability, water quality, construction technology, environmental/social impacts, water-leaders forum etc.

This workshop will also provide its delegates with the perfect opportunity to interact during the workshop and provide a fantastic networking opportunity where engineers, researchers and professionals can keep pace with the latest developments, share experiences, lessons learnt and changing business needs.

Highlights of Inauguration of IACRR India Chapter

On Monday, December 4th, 2017

The inauguration of the India Chapter of IACRR was held with a vibrant function and technical workshop at the Dayananda Sagar College of Engineering (DSCE),Bangalore on the 4th of December, 2017 to create awareness on water, sanitation and health. Dr. C.P.S. Prakash, Principal, DSCE welcomed the guests and the delegates. The event was preceded by the inauguration of the India Chapter of 'International Association for Coastal Reservoir Research (IACRR)' by Prof. TG Sitharam, IISc (President, IACRR and Patron Indian chapter). 'India is not running out of water, but water is running out of India' said Prof. Sitharam. The currently available water solutions are unable to satisfy people's increasing need for water. As far as rain water is concerned, certain area receives more rain thereby causing floods and excess rainwater discharge into the sea. Hence, the solution lies in utilizing or conserving the abundant monsoon water which runs off into the ocean in the coastal reservoirs. Coastal reservoirs enable the storage of excess river flood waters near the coast for future use.

Shri Janardhana Swamy, former MP and former member of IIT council, Govt.of India had congratulated the future thoughts of Dr. T.G. Sitharam and shared couple of things about the importance of water to the growth of any city, and the impact of population growth. He briefly shared facts of water crisis faced by Chitradurga district, where the water is pumped from 200 kms away from Tunga reservoir and the nearby Vanivilasa dam never filled in 100 years. As earth is the only planet holding water, he mentioned that it is our responsibility to sustain without damaging rivers. Also he mentioned that he is implementing electronic sensors to monitor the quality of water.

Mr. Kushal Shetty (Chairman, India chapter of IACRR) was very glad to be at the Launching ceremony of India Chapter of IACRR at DSCE Campus. He addressed the gathering by honoring the galaxy of experts coming from different continents, who are interested to promote coastal reservoir concept. He said that impounding of river flood water using sea based reservoirs and pumping the same to the required area is the only permanent solution for water shortage in the future. He expressed his happiness to lead the India Chapter of IACRR. He assured to make this society a great achievement with all the experts with their scientific temper and commitment. Dr. Ramesh H and Dr. Sreevalsa K (Secretaries, IACRR), were happy to create a historical moment to open the India Chapter and be a part of it to spread the word and popularize this amazing concept. They encouraged all the water planners to work together and assured a better water solution for our cities, which is cost-effective, environment friendly, socially acceptable with low carbon emission.

Prof Roger A. Falconer, Cardiff University, UK gave a technical presentation on Coastal Reservoirs: Opportunities for Water Security, Urban Regeneration and Renewable Energy. He highlighted the water management challenges that the world is facing, anticipated impacts of climate change, increasing need to provide more water, food and energy for a growing global population, and the increasing globalization. It is therefore timely that we look to the future to address some of these challenges in a sustainable manner and working with nature to develop coastal reservoirs to contribute to the solution of some of these challenges.

Prof Shu-Qing Yang, University of Wollongong, Australia delivered a talk on 'Coastal Reservoirs that treat water as Prasad, not to waste'. He highlighted that in India, every year we waste 854km3 of floodwater to the sea. He envisaged to provide sufficient, high quality, and affordable water to the world with minimum environmental/social impacts through the coastal reservoirs. The global water crisis is not caused by water shortage, but storage shortage; caused by the wrong assumption that people can only construct dams in mountainous areas, not in the sea. Coastal reservoirs are freshwater reservoirs whose dam is situated in seawater environment.

Prof T.G. Sitharam, Indian Institute of Science, Bangalore made a presentation on Coastal

Lighting of Lamp/Inaugural Function

Reservoirs as an alternative source of fresh water: Opportunities, Issues and Challenges. Coastal reservoir has many advantages such as no land acquisition problems, no land submergence and forest submergence like in inland reservoirs. They are already put to work in countries like the Netherlands, Singapore, China, South Korea, Hong Kong, etc and proven to be beneficial. They are designed with gates so that the excess flood water, which is more than the capacity of the reservoir that can be discharged into the sea. Having a lengthy coastal line, India has huge potential to adopt the concept of coastal reservoir to ensure fresh water for all and sustainable development of coastal areas into freshwater townships self-sufficient in energy.

Gratitude was extended to all distinguished speakers by Dr. H.K.Ramaraju, Vice-President of India Chapter, IACRR. He acknowledged the important contributions of all the workshop participants. Participants from different parts of the country and from neighboring states have participated in the workshop. Technocrats from Mines and geology, Central groundwater board, BWSSB, GSI, faculties/ researchers from IISc, Bangalore, members from IWWA, Coastal Engineering consultant, KUWSSB, Professors from AMCEC. DSATM, DSIT. Totally 150 participants had attended the workshop from 4:00 PM to 7:00 PM and from 7:00 PM to 7:45 PM, an interactive session was arranged.

Office bearers of IACRR India Chapter

Article

Water Scarcity & Availability: Innovation Challenges

by
Prahlada Ramarao** and T G Sitharam*
** Pro Chancellor, SVYASA
* KSIIDC Chair professor, and Senior Professor, Department of Civil Engineering, Indian Institute of Science, Bangalore

"There is no scarcity of water; there is a scarcity of Innovation"

The whole country has periodically witnessed the serious dimensions of the water war between Karnataka and Tamil Nadu. This is a classic example of state governments who act without any long-term plans, to get political mileage out of crisis and the reactions that then happen from the public, with all its emotions. It is brought out here that there is enough water resources in India for all, if we manage the same through innovation and sustainable technology. Though there is a limited availability of surface water, there is also enough flood waters throughout the country, which simply runoff into the ocean in the 4 months of the monsoon period. The annual storage of fresh water per capita in India is very low when compared to many of the developed countries. India already has built more than 5000 dams (India is already in 3rd place in the world after China and USA in number of medium and large dams). Any expansion or increasing the capacity is not sustainable. It is therefore important to increase the storage capacity of freshwater, with an innovative approach to secure the green environment, agriculture and support all livelihoods.

Loss of Freshwater: On an average, India receives about 4000 Billion Cubic Meters (BCM) of precipitation (includes rainfall and snowfall) every year. Especially along east and west coasts of the country, rough estimates of west flowing rivers Netravati, Narmada, etc. add up to 276 BCM (9800TMC feet; 1 BCM=35.3 TMC ft) of water every year. Assuming that 45% of average monsoon rainfall during the floods runoff into the ocean, it will be about 4400 TMC ft (125 BCM) of water from West flowing rivers draining into the Arabian sea. Similarly on the East flowing rivers; Krishna, Godavari, Kaveri, Mahanadi discharge 350 BCM (12500 TMC ft) of water and out of this, 160 BCM (5625 TMC ft) of water per year flows into the Bay of Bengal beyond the storage capacities of the existing dams and natural water bodies in about 4 months of monsoon season. Figure 1 illustrates the scenario through Sankey diagram. This huge amount of water just merges with the salt water of the oceans when there are severely water stressed cities and towns in Tamil Nadu, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Madhya Pradesh and Orissa. These calculations do not even consider other sources such as ground water and other surface waters stored in lakes and tanks.

Drinking water requirements demand about 2500 Tmcft for the entire population of India with an average 150 lpcd(litres per capita per day) and less than 1000 TMC ft is required for all the cities in India (taking 34% of Urbanization). This reserve is too small when compared to that of the developed countries. Thus, we see the big irony in not meeting the basic requirements of people, when there is more than adequate availability of drinking water every year. It is therefore wise to invest in storage of the excess flood water (which is reasonably diluted and cleaner) in the ocean i.e., fresh water in sea based reservoirs close to the place where the river joins the sea.

Issues with Current Schemes:

India has built more than 5000 dams so far. Dams are constructed at a number of places to stop running water of the rivers and then store the water. Subsequently, they are piped and/ or pumped to meet the drinking water requirements of the people. The land area that gets submerged (mostly very precious agricultural lands and villages /towns)

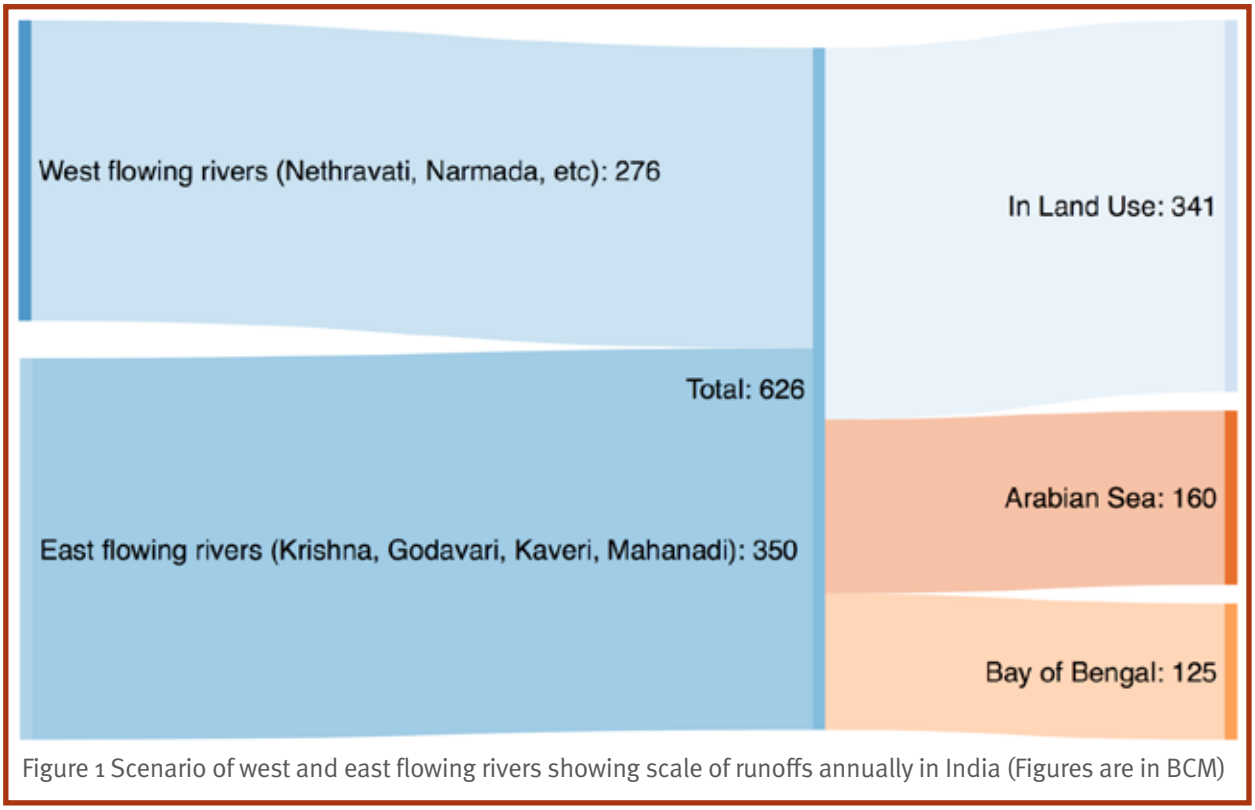


Figure 1 Scenario of west and east flowing rivers showing scale of runoffs annually in India (Figures are in BCM)

is not clearly quantifiable and no data exists in the public domain for all the dams. Available estimates of people displaced by the large and medium dams in India show that the 140 dams for which such figures are available, have displaced over 4.4 million people. However, firstly, these are only government or World Bank estimates and hence are likely to be very conservative figures. Secondly, these are figures of people displaced by the reservoirs only, and do not include people who are displaced by the related works of dam projects like the canals, colonies, downstream impacts, compensatory afforestation, catchment treatment and sanctuaries. With the strict environmental regulations and guidelines, there is no possibility of constructing new dams as there is an acute shortage of land; and there are serious issues of displacements and compensations and rehabilitations associated with this.

Essential to Find Technology Solutions

In the peninsular rivers in India, there is no contribution from snow melt and monsoon flow accounts for more than 90% of the annual flow. Due to this uneven distribution of flow in both time and space, it is possible to utilize only a small portion of it in India. It is estimated that out of the 4000BCM of precipitation, the annual flow in the rivers is only 1869 BCM, out of which only 690 BCM can be put to use so far. Another 432 BCM has been drawn from ground water. Thus, the total utilizable quantity of water is 1122 BCM per year. Trans-basin transfer of water, also called the interlinking of rivers, will enable the utilization of an additional 200 BCM of water.

India's water challenge is to conserve the abundant monsoon water bounty, store it in reservoirs; and use this water in areas which have occasional inadequate rainfall or are known to be drought-prone or in those times of the year when the water supplies become scarce. India currently stores the rainfall received, which is slightly less than the developed nations (Internationally countries store 900 days of water demand in arid areas, river basins and reservoirs as a strategic plan). India's dam reservoirs store only 174 BCM. India also relies excessively on groundwater, which accounts for over 50 percent of irrigated area with 20 million tube wells installed. About 15 percent of India's food is being produced using the rapidly depleting groundwater. The end of the era of massive expansion in groundwater use is going to demand greater reliance on surface water supply systems. Proponents of the project suggest that India's water situation is already critical, and the country needs sustainable development and management of surface water and groundwater.

Today, there are other technologies like water desalination, water recycling from waste water and sea based reservoir, etc .including those that are in operation and in planning and construction stages. About 1200 BCM is available for storage in sea based reservoir without creating an environmental impact.

Concept of Sea Based Reservoir:

In a tropical country like India with high evapo-transpiration, drinking water security can be achieved with solar energy security to pump water to uplands from the water surplus at lower elevation i.e. from reservoirs at the sea level. The solution for drinking water lies in storing flood water in sea based reservoirs, as this does not submerge the lands which are of immense value. Sea based reservoirs can be constructed in shallow waters at appropriate locations close to the mouth of the river, along with a barrage at one or two ends. Sea walls or breakwaters with some modifications are good enough to construct the sea based reservoirs. This concept envisages a sea based reservoir which stores fresh water, while the bottom of the reservoir is a mixture of sand and rubble. By keeping out seawater, by the construction of sea wall close to the mouth of the river results in the fresh water reservoir in the ocean. Sea based reservoir is part of the river watershed, which is formed by the convergence of the rivers and the ocean. The reservoir / the ponds have an average depth of 10 to 20m with a maximum depth of 30 m.

When it rains heavily during low-tide, the sea reservoir outflow crest gates will be lowered to release the excess rain water from the reservoir into the sea .If there is heavy rain fall during high-tide, the outflow crest gates remain closed and a large reservoir of about > 100 TMC ft can be designed so as to absorb the shocks during high tide and release water out to sea only during low tides.

Even the sand, silts and salts can join the ocean partly through the sea based reservoir. The emergent vegetation can cover about 20% of the surface area of these artificial fresh water reservoirs or ponds making it environmentally friendly. More species of fish can call these ponds a home! This reservoir will increase India's fresh water supply for generations to come and use the rivers flowing into the Arabian Sea and the Bay of Bengal.

Advantages of Sea based reservoirs:

Sea based reservoir has many advantages such as no harm to any river basins; it does not disturb the forest cover and no displacement of people and their villages. Ground water recharge can increase in the area along with the minimization of coastal erosion. Fresh water sand dredging can be permitted in the fresh water reservoir. The entire length and width of sea wall can serve as a deep water fishing harbor and will benefit the fishing community enormously. This reservoir does not affect any deep water activities in the basin and helps the fishermen and others to reach deep waters much more easily. Sea based reservoir would create a path for aquatic ecosystems and it is environmental friendly. The sea wall structure is earthquake resistance and it is very safe against earthquakes.

Construction of sea based reservoirs costs about Rs 2000-3000 crores per BCM of water. In view of the recent Karnataka –Tamil Nadu issue and to avoid the worsening water war situations in the future, the country has to find solutions and mechanisms. There are several Public Private Participation Projects successfully implemented in the country by sharing funding requirements between the government – Public, industry and private institutions. For a country like India generating about Rs 20,000 crores to store 10-15 BCM over 10 years is not at all a challenge.

These projects are long term in nature, running over 7 to 10 years. Therefore, water being a state subject, there is often a situation when political agendas mar these strategic projects and the decision making process is long and confusion filled. This can be an impediment for these projects.

Funding Mechanism and Management:

In view of the scenario defined above, funding 10's of thousands of crores and ensuring proper implementation and project management becomes much more complex. This concept of coastal river reservoir needs inclusive support from the Centre, PPP, State Government funding and from international sources such as the World Bank. Foremost Innovative solutions need to be firmed up. One strong candidate is forming a dedicated SPV (Special Purpose Vehicle) with equity participation from Public and Private Entrepreneurs, State Government,

Central Government, financial institutions, eminent personalities, and Venture capitalists etc.

Of course adequate autonomy needs to be provided for this SPV to function effectively, regulate the activities and complete the project as scheduled.

It is already late:

The condition of availability of drinking water in towns, cities and megacities will only worsen as the years go by. Availability of land for water management will become almost impossible. The only practical solution is to house the storage of water in the sea and close to river mouths. This is on similar lines as new power stations and agriculture fields coming up in seas as floating platforms. It is time that all opinion makers and implementers consider this inevitable solution and ensure early decisions.

Advantages of Coastal River Reservoir

In earlier times, Major highways in UK (Motorways), Germany (Autobahn), Malaysia and Highways in the US were built with an objective of providing faster routes to the neighboring towns and cities. Eventually, these roads now have become economic corridors of major business activities and easing transportation of goods and services. Economic activities include hotels and motels along the highway, shopping and entertainment complexes, camping sites, fueling and service stations for the vehicles, medical centers all along, communication, radio and TV channel availability along the highways, tourist spots and relaxing breakaways .etc.

These highways have encouraged development of new technologies in automotive, entertainment, fast food chains, supply chains, road construction and many more. No one had thought or predicted about such developments and growth in the economy.

Similarly, the Coastal River Reservoir today could be a small step to bring clean and perennial water supply to needful regions through innovative approach. But its impact on life around the reservoirs far and wide could be beyond the imagination of today. Human beings are creative and will bring out wonders as always.

Following are some of the immediate benefits leveraged by the Coastal River Reservoirs.

Off Shore Agriculture - Scarcity of water primarily affects the vegetation, flora and fauna on mainland. Water for agriculture is affected directly due to the crisis of water shortage, subsequently leading to the shortage for food. On the other hand, limitation/availability of land for agriculture purposes is also a growing issue today.

Most innovative co-benefits from coastal river reservoir is the option for off-shore agriculture, where the area along the embankment or large floating raft could be used to cultivate food crops. Utilize the stored freshwater. Off-shore agriculture concept could be the next generation innovation to address food security.

Water Sports - Activities associated with water such as scuba diving, kite surfing, wind surfing and others water sports can find a suitable destination. Where locals, professionals and tourists could experience the attractions. There is scope for hosting major international and national sporting events attracting new business.

Tourism and Hospitality - Development of Hotels, Boat/ship houses, and water resorts are some of the inclusive economic growth that could be envisaged using Coastal Reservoir. Such concept could attract people to experience and create new, innovative tourism market.

Deep Sea Fishing - Fisheries and aquaculture are some of the regular activities of coastal habitat, yielding variety of fishes, prawns, exotic ornaments such as pearls. According to reports from UNFCCC- COP 15, Fisheries and Aquaculture provide direct and indirect employment to over half of million people in developing countries.

Coastal reservoir could be attractive options to fishermen to reach further deep into the sea and at the same time create freshwater fish farms within the reservoir. Additionally, fishermen could reduce the risk travelling far into the sea and at the same time gain the opportunity to improve the quality of life.

Sustainable Energy-Energy is equally essential as water. The nexus of water and energy has always existed and largely understood by the linkages between each other. Renewables are the next big thing and future prospects in India.

All such primary activities trigger economic activities. In addition, they also trigger secondary activities in new technologies, business, recreation, sports goods, fishing, boating, water sports, and aeronautical activities in drones and so on. These secondary activities will also trigger further tier-2 economic activities and the chain thus continues resulting in wealth and employment generation through decades.

There is a huge scope for harnessing renewable energy capacity using coastal reservoir as India is one of the largest country in the world; and is geographically well positioned, such that the country receives incident energy between 4-7 kWh/m2/day. As on 2017, India has only managed to install 12 GW of solar power, generating 1% of total supply. Solar energy is both land and cost intensive infrastructure. Availability of suitable and accessible land has been a challenge, especially for renewable energy. In this regard, CR could be attractive for policy makers, developers to use the space on the embankment to install solar parks.

Similarly, options for deep sea off shore winds farms capturing the best wind density and encouraging other technologies such as wave and tidal energy.

Shipping and Docking - Ports are the gateway for intercontinental trade though sea route. Thousands of ships dock each day for loading and off-loading of goods. Space is one important factor at the harbor and ports to accommodate the stock. CR could be advantageous in this regard, leveraging the widest space to dock ships. Thus, this will reduce the waiting time and ensure efficient transportation of goods and services.

Overall, there are positive signs for perennial business opportunities and at the same time enable sustainable development around the coastal reservoir. Due to rapid economic activities, population around this region leverage with most advanced inclusive growth opportunities. The entire economy around this water body will prosper by witnessing

- large commodities trade activities increasing sales and services
- Growth in real estate which is an important indicator as wealth linked to value of residential and commercial built environments.
- Industrial activities - Major and Small scale manufacturing enterprises will benefit most in-terms of having ready market next door.
- Employment - new job creation for young graduates and opportunities for professionals from multi-disciplinary areas. This is also one of the important factor or indicator sustainable economy
- Value of Indian Rupee increases, weakening the dollar. Eventually, imported products from US and other developed countries becomes less expensive. More goods can be imported/exported, positively amplify sales. Economy recovers with more influx of foreign currency.

"Countries can live without high-tech industries but they cannot live without water; Water is bigger than IT, BT and Aerospace Industries. It is wise to invest in water. Even food can be imported but it is very difficult to import water."

"It is my pleasure to wish all members of IACRR a Very happy New Year. This year promises many new things for IACRR at the International level and let us all work together to ensure IACRR reaches new heights."

Prof. Jun Xia
Vice President IACRR
Vice-president, Academician of Chinese Science Academy;
Former president of the International Water Resources Association (IWRA)

AWARDS AND FELICITATIONS CONFERRED BY IACRR

Dr. Sreevalsa was awarded a certificate of merit for organising an International workshop on Coastal reservoirs at Coimbatore, India.

IACRR Fellow was conferred on Prof. Shuqing Yang, Director of Coastal Reservoir Research, University of Wollongong, NSW, Australia.

Prof C Sivakumar from UoW receiving certificate

Prof Sitharam with Dr B R Shetty patron of IACRR at KL Event

Prof Roger Falconer VP IACRR receiving certificate from President Prof Sitharam


Receiving Dr Shetty and his wife arrived by DR. B.R SHETTY'S GULF STREAM G450 AIRCRAFT
at Sultan Abdul Aziz Shah Airport at Subang, selangor Malaysia

TESTIMONIALS

I had participated in the coastal reservoir workshop held at Amritha University and Sahyadri Engineering College.The efforts made to provide fresh water to the coastal city is appreciated. But there is a dire necessity to rejuvenate the river basin which would sustain the flow addressing environment as well as the needs of the human beings in upstream right from the origin of the stream network. Unless the natural ground water recharge takes place in the entire basin upstream the flow cannot be sustainable.Otherwise the erosion and siltation of water bodies will lead to the ravage of the river system and the purpose of the project will not be achieved. Hence it is my suggestion to take up the rejuvenation basin wise as part of the project before venturing any efforts to harvest fresh water for the needs of the cities.

– Dr. Lingaraju Yale
Founder Director, Karnataka State Remote sensing Centre

Water is precious. If no water, no life. The availability of potable water is depleting day by day. If the present trend continues, there may be fights between the states and countries for potable water. It is a right time to think of innovative concepts in the rainwater storage (surplus water). In this direction, India has taken a lead role under the leadership of Prof. T.G. Sitharam, President- IACRR (International Association for Coastal Reservoir Research). The IACRR was officially inaugurated at Kuala Lumpur. The inauguration was done meticulously in a traditional way. The IACRR local chapter has also done tremendous work towards Indian coastal reservoir research. I strongly believe that the IACRR will come out with a solution for water scarcity not only for India but across the globe.

- Prof. K Muthukkumaran, NIT Trichy

It was a pleasure to attend the launching ceremony of the International Association for Coastal Reservoir Research (IACRR) in August 2017. The launch marks a new era in global thinking 'outside the box' on fresh water storages. Nearly 2/3 of the world population experience water scarcity at least one month in a year. I believe IACRR has a significant role to play in research and development as well as on advocacy on coastal reservoirs as a solution to water scarcity problem worldwide. I am delighted to be a founding member of IACRR.

- Prof M Sivakumar, University of Wollongong Australia

The first International workshop on Coastal Reservoirs in India and Review meeting of BWSSB Project was held at Amrita campus on 19th July 2017. Many dignitaries including PadmashriDr. PrahaladaRamarao, Prof. Shu-Qing Yang of University of Wollongong, Australia and Prof.Sitaram of IISc Bangalore participated in the Workshop. The workshop provided an excellent platform for sharing the novel ideas in the emerging concept of coastal reservoirs. Deliberations held on feasibility of a coastal reservoir to impound Netravati river flood waters paved a way towards a sustainable strategy for water resource development for Mangaluru and Bengaluru.

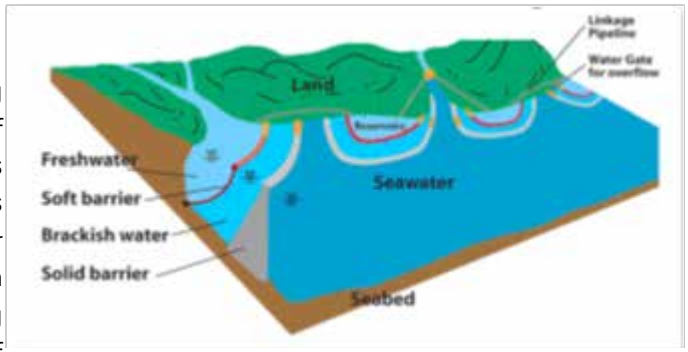
- Prof Manoj P. Samuel, ICAR-CIFT, Kochi

AWARDS TO STUDENTS' PRESENTATION ON COASTAL RESERVOIRS

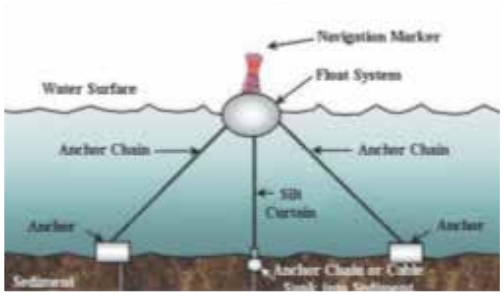
An abstract on concept of 'Coastal Reservoirs' submitted by B.Tech students of Amrita Vishwa Vidyapeetham was shortlisted for paper presentation at Think India RISE Summit 2017 held during 13-14 October 2017 in Coimbatore. They have won first prize in paper presentation under the theme 'Innovation' and overall second prize. Faculty and students from various institutes in India particularly from Tamil Nadu were present during the session. Dr. Bhimaraya Metri Director, IIM Trichy inaugurated the event which was graced by technocrats and entrepreneurs from different parts of the country. Think India is a pan India forum of students and faculty from premier institutes of India, to bring together the best talents of the country, inspiring young India to be of service to the society. It is a platform for the Leaders of Tomorrow where they deliberate on issues of national and social importance, raise their concerns and offer innovative solutions to the problems faced by society. Students' names: Anagha Murali, Narayanee V, Nitish Kumar, ES Nisanth, Praharsha BS, Samyukta Sathish, Sirpi AS.

COASTAL RESERVOIRS CENTRE AT UNIVERSITY OF WOLLONGONG

Securing sustainable water supplies to meet the needs of ever-growing coastal populations is a major challenge faced by water authorities across the world. The conventional approaches to dealing with this challenge are framed around the long standing notion, 'shortage of water', which by its very nature limits the scope for exploring the feasibility of innovative solutions.



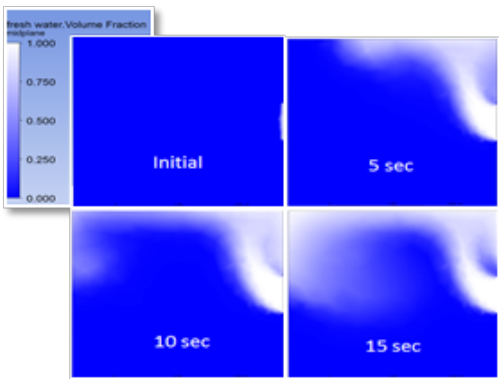
Research undertaken at the University of Wollongong (UOW) over the past decade has led to the development of a novel solution approach that shifts the focus of the world's water problem from 'water shortage' to 'water storage'. This solution approach involves an innovative coastal reservoir (CR) design that will harness flood water at sea, at a fraction of the cost of the desalination technologies currently being used. This innovative design of CRs also addresses most of the limitations associated with the first generation of CRs that have been adopted in several countries; for example, the Marina Barrage in Singapore, Plover Cove in Hong Kong and Sihwa Lake in South Korea.



Building on its pioneering work in this area, UOW's Faculty of Engineering and Information Sciences has taken a crucial step to expedite the development of CRs by setting up the world's first-of-its kind Centre for Coastal Reservoir Research (CCRR). Through this initiative, UOW has been able to assemble a strong multidisciplinary research team with vast experience and reputation in all requisite areas, including: water resources and coastal engineering, water quality and environmental engineering; geotechnical and structural engineering; and modelling and simulation. This has also meant that CCRR is now able to contribute to any future CR development efforts with the following capabilities.

CCRR Capabilities:

- Conceptual Development and Feasibility Studies
- Detail Design and Analysis
- Water Quality Assessment and Treatment
- Coastal Engineering
- Project Evaluation and Risk Assessment
- Modelling and Simulation
- Feasibility studies of Multi-purpose CRs



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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.

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