SEPTEMBER 2021

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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Flood Management in Built Environment

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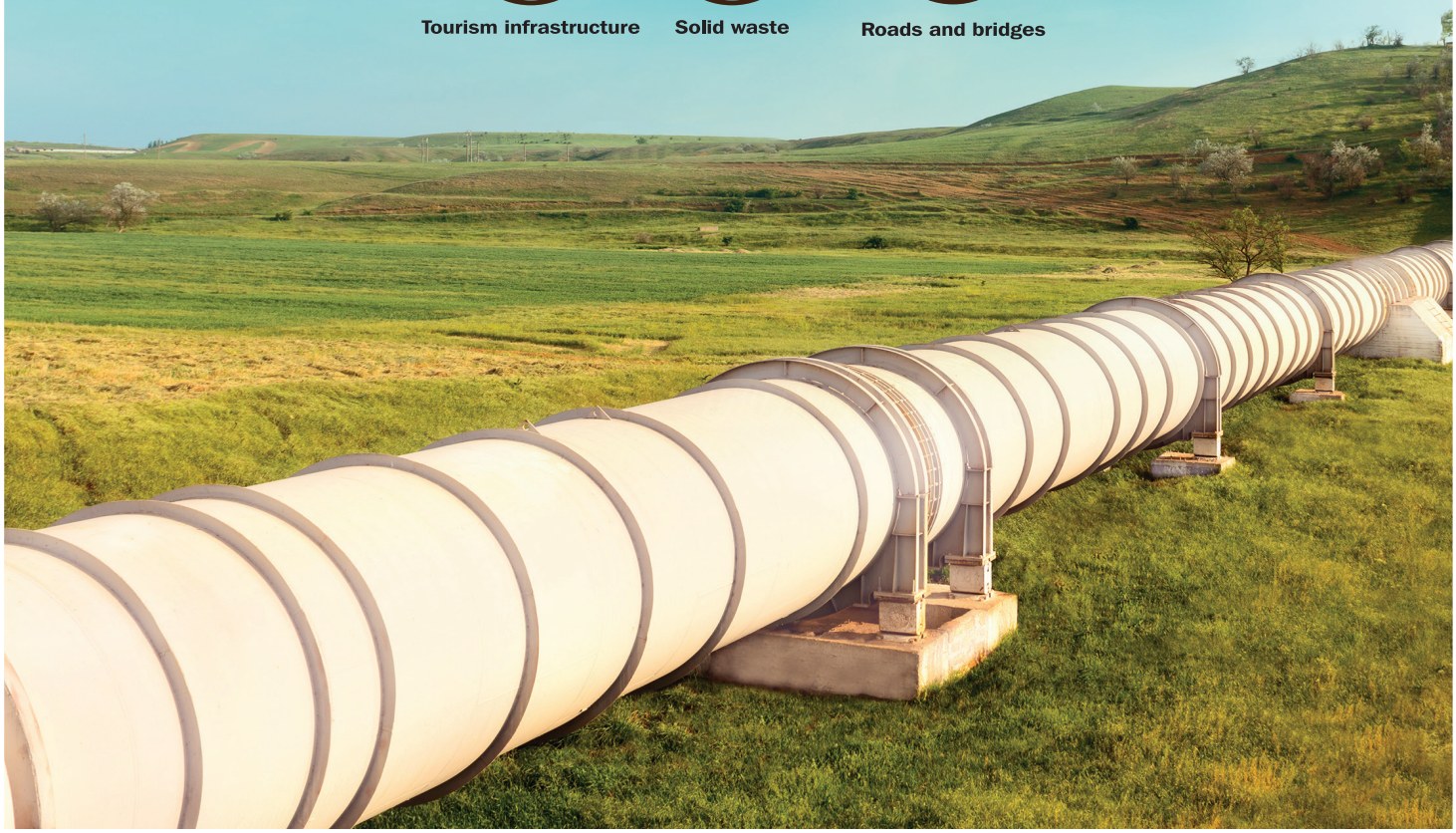

SHAH TECHNICAL CONSULTANTS PVT. LTD.

Mumbai
#407, Raheja Centre,
Nariman Point, Mumbai – 400 021.
+91 22 22871061 | stc@stc.co.in

Chennai
Old No. 43/2, New No. 24/8,
Vijayaraghava Road (Adjacent to Andhra Club),
T. Nagar, Chennai – 600 017.
+91 44 28150573 | stc.chennai@stc.co.in

Jaipur
#32, Lions Colony, Opp. Morani Motors,
Sitabari Tonk Road, Jaipur – 302 018.
+91 141 2552981 | stcjaipur@stc.co.in

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About CEAI

Consulting Engineers Association of India (CEAI) is the apex body of consulting engineers in India having membership of organisations as well as individuals. The membership represents large, medium and small consultancy companies/ organisations both in the private and public sector and eminent individual consultants. EPC organisations are also members of CEAI since they have planning and design engineers, apart from construction management consultants.

CEAI is the Member Association, of the International Federation of Consulting Engineers, commonly known as FIDIC, the acronym for Fédération Internationale Des Ingénieurs-Conseils, representing the Consulting Engineering Fraternity in India. FIDIC has membership of more than 100 Member Association of various countries and is headquartered in Geneva.

CEAI was incorporated in 1996, with the merger of two leading national associations Association of Consulting Engineers (India) {ACE(I)}, incorporated in 1960 and National Association of Consulting Engineers {NACE}, incorporated in 1976. Thus, CEAI has, behind it six decades of accumulated knowledge and experience.

- CEAI promotes the interest and works to enhance the status of the consulting engineering profession in India
- CEAI advocates global networking and co-operation
- CEAI's activities include:
  - Quality development of Consultants.
  - Productivity enhancement.
  - Promotion of ethical practices.
  - Facilitation and interaction with government and other authorities/ bodies to streamline and improve the system of engagement of consultants.
- Regional Centres in Jaipur, Bengaluru, Kolkata and Mumbai to broad base activities.

Aims & Objectives

- Promote the professional interest and establish the rights and privileges of the status of consulting engineering profession in India
- Represent the consulting engineering profession within India and abroad. Connect the members locally and globally.
- Disseminate among the members information on all matters pertaining to engineering, especially knowledge and information related to consulting engineering profession by way of holding Conferences, Seminars, Courses, Workshops, Field/ Site Visits, etc. and thus assist in Continuing Education for the Professional Development of Members.
- Act as the principal champion for consulting engineering profession through constantly informing and educating the public and lawmakers about key engineering issues and making it possible to have the voice of the profession heard by the policy makers.
- Promote adoption of equitable forms of contracts and other documents used in consulting engineering practice.

Vision

- To represent, promote and enhance the status of consulting engineers in India as an honoured and dignified profession for nation building and propagate Indian engineering consultancy globally.

Mission

- Promote interests of the consulting engineering profession nationally and internationally.
- Promote sustainable, safe and sound engineering practices.
- Upgrade engineering knowledge and skill.
- Propagate code of professional ethics, safety, health and environment.

Values

- Commitment with tenacity to high ethical values, integrity, professionalism and achieving technical excellence and inclusive development.

Code OF Ethics

- CEAI has adopted a Code of Ethics, to which all members must abide. It is not just for the quality of the jobs they work on, but for the safety and well-being of the public at large.
- CEAI is the profession's most respected voice on the practice of ethical engineering.
- The code specifies the responsibilities of Consulting Engineers towards the society as well as the profession, to refrain from performing services unless competent to do so, to act in the legitimate interest of client, to be impartial, to maintain ethical relations with other consultants.

CONSULTING ENGINEERS ASSOCIATION OF INDIA

Creating Value Ethically for Engineers

Engineer's Day

The World is realising the importance of Engineers - the builders of nations.

It has also dawned on the powers that be that Nature is Supreme.

Man must abide by the Laws of Nature.

Build and live in harmony with Nature.

Any alteration of Mother Earth should take in to account the long term effects so that Future generations can also live off the bounty of Nature.

Sir Mokshagundam Visvesvaraya was one such engineer who always had the welfare of the people in mind and for that he conceived, planned and executed pioneering projects. Today the nation pays homage to Sir Visvesvaraya on his 161st birth anniversary.

We Engineers must solemnly affirm that:

We will serve the nation,

Do what is right and sustainable,

With honesty and integrity,

For the benefits of the people in all strata of society,

For the Nation to grow and prosper.

Pledge that as an Engineer our shibboleth will be

"Engineer to Build Sustainably"

Dr. Ajay Pradhan

President

MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers & Readers,

"Water, water, every where, Nor any drop to drink"

The lines by Samuel Taylor Coleridge in his poem "The Rime of the Ancient Mariner" aptly sum up the situation in many countries across the globe – the list is too long to record here, caused by the torrential rains. They are being attributed to Climate Change. However, the question that needs to be addressed is as to WHAT all caused the Climate Change in the first place? The deliberations and the findings over the years have left no doubt that it's manmade. Yet every person thinks that it's the other person who is to be blamed. The same is the case with towns, cities, states and countries. Each considers oneself or itself as the only being or entity that matters. The fact that Earth was created as one planet is lost sight of. All parts of the Earth are connected and any play with Nature in one location not only affects that location but also other locations, adjoining areas and even areas remote from the original area: the greenhouse effect – melting of ice cover in the poles and mountains, breaking of dams created by moraines, starting of avalanches, overflowing of cirques, flooding of rivers, etc.; it's a chain of events that humans have no control on. The above is amply corroborated by the Sixth Assessment Report of the Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC), which was released recently. The first three statements of the Report are:

A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

A.2 The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.

A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5

There is therefore no doubt that humans must change their thinking and behaviour so as to abide by the laws of Nature, live in harmony with Nature to ensure that there are no rebounds that could affect the current and the future generations.

Coming down to what affects the people in their day-to-day activities, it is the flooding that is increasingly occurring in the built environment – be it urban, semi-urban or rural. The effect of that in the built environment is immediate since it upsets the life of all the habitants of the affected areas. The losses to all are staggering, since life and thus the economy comes to a standstill and when the floods subside the limping back to normal takes time for all due to loss of human lives plus the widespread damages to property, articles, goods, food stock, livestock, etc.

The way forward should be thorough holistic integrated planning, factoring all the elements and systems necessary to make the resultant plant, equipment, products, works, etc. to function coherently and perform as necessary to yield results. The planning, design, construction and operation teams must work in unison right through the project and even during its running life.

CEAI has been actively promoting the causes and the interests of the Engineering fraternity with the Ministries and Departments concerned. Some of these are given in the News section.

For the benefit of all, CEAI has been holding webinars on various issues – technical as well as non-technical. Those held in the last quarter are reported in this issue.

This issue on "Flood Management in Built Environment" presents case studies based on the experience of our colleagues and shows the way forward for managing floods in the built environment.

It is the duty of the Engineers and so also that of the Planners and Authorities to plan, provide and preserve the built habitations in a manner that will be in harmony with the elements of Nature. All need to work ethically and better their best so that the country becomes free of the menace of floods. These factors are echoed in the columns of the Guest Editor and also in all the articles of this issue. Lastly, the lyric on Engineers, says it all.

Sincerity, Tenacity and Professionalism – The Key to Sustainable Development

Happy Reading & Learning

A P Mull

MESSAGE FROM GUEST EDITOR

The current issue is based on the theme "Flood Management in Built Environment" for which a dire need was felt. The growth in India has been phenomenal and today it is one of the world's fastest growing economies. Rapid urbanization and industrialization are adding pressure on the existing infrastructure in terms of employment, housing, water, sewerage, drainage, power, other services and allied facilities. Keeping pace with people's requirements is needed but with due consideration to all Sustainability aspects and those of Environmentally safe designs. The Government of India launched various development programs including Smart Cities, Atal Mission for Rejuvenation and Transformation (AMRUT), Mass Housing, Delhi Mumbai Industrial Development Corridors (DMICDC) and others to address and provide the basic necessities and employment requirement.

All these human centric developments which are leading to increase in urban areas and industrial estates on vacant land and are transforming the land use pattern, resulting in increase in non-porous surface, encroachment on natural water bodies, green cover areas and thus pose challenges since the run off generation is high in urban areas with limited underground percolation and with much larger quantum of rainwater reaching the storm water drains.

The effects of climatic changes are more visible now than in the past, with the environmental effects becoming more broad based, as is evident everywhere. It is impacting urban areas, especially the habitations near rivers, lakes, oceans, and snow. Extremely dry weather, heat waves, draughts or intense monsoon, severe thunderstorms, cyclones, avalanches are making life difficult.

The urban planners and the authorities need to take serious and urgent cognisance of these and address them at the planning stage itself. Well thought of plans incorporating integrated holistic development are required, infact necessary, with long term perspective to create better infrastructure to handle drainage in built up areas.

The United Nations General Sustainable Development Goals also address these issues. Goal 11 calls for making cities and human settlements inclusive, safe, resilient and sustainable while Goal 13 is a reminder for taking urgent action to combat climate change and its impacts.

The Central Public Health & Environmental Engineering Organisation's (CPHEEO's) Manual on Storm Water Drainage systems provide guidelines including various design aspects. In view of short duration, high intensity rainfall, the design return period has been revised to once in five years for Class-1 cities and once in two years for other cities. For airports and critical infrastructure, the design return period has been recommended as once in 100-years for Class-1 cities and once in 50-years for other cities. It also allows higher return periods to be adopted for design under exceptional circumstances. These are welcome changes which have been incorporated in the CPHEEO Manual in 2019. For metropolis areas such as Mumbai, Delhi, etc. it would be prudent to adopt a 100-year return period. It would be false economy to try and save on capital expenses but incur much more for rehabilitation of the economy and rebuilding the buildings and the infrastructure that get destroyed fully or partially annually on account of flooding.

The Government of India launched Digital initiatives to cover 30% increase in citizen service levels by 2024. The Smart City concepts provide city based communication systems which capture data from all infrastructure assets. The adoption of digital communication enhances the utility of early warning systems for flood prone urban habitations.

Best practices in other cities of the world can also be used as guidelines and alternatives for review, discussion and adoption. In Singapore, rainfall is collected in artificial reservoirs that collect water from carefully managed catchment areas and used as an alternate source of water. The Sustainable Drainage Systems (SuDS) like permeable pavements, green roofs, landscaping, swales have been provided in places like Singapore, Barcelona, Cannes, Songdo, Canary Wharf, etc. These do help to ameliorate the problem but are not the final solution.

During the Planning process of an urbanized area, Urban Planners, Infrastructure Planners and Utility/ Services providers need to work hand in hand for better project delivery. The surface runoff after development is higher than the runoff before development. The urban planners need to plan and retain the existing topography and natural features to the maximum extent. Spatial planning requires more open spaces, landscapes, selection of paving material which allows underground percolation, integration of rainwater harvesting structures, water detention ponds, etc. Within an urban area itself, the level of a road and the invert levels of stormwater drains and sewers, all of them, must be based on the levels of the adjoining areas so that free flow by gravity from the adjoining area is not hampered. Roads and highways, connecting urban areas should not become barriers for the natural flow of water. Adequate cross drainages must be provided as part of the design of the storm drainage system to cater to the design rainfall intensity and for leading the stormwater to water bodies, rivers, nallas, sea. They are extremely necessary for addressing the flood and storm water management in the Built Environments and the interconnections of those areas. Similar considerations must also be used for railway lines. The main consideration in all cases should be to ensure that all areas can drain freely by gravity with no ponding or water logging. Release of water from reservoirs has also been creating enormous issues. The requirement to address those cases are more accurate storm forecasting, better monitoring and surveillance. Those are areas of natural drainage but are closely and inextricably linked to urban flooding. To truly address the issues the requirement is of holistic and integrated planning at all levels based on the principle "working from the whole to the part" i.e., from National to State to District to City to Town to Villages and also the non-urban areas.

Engineers, Planners & Authorities - All Need To Coordinate Planning and Execute Sustainably

Dilip G Sonwane
Associate Vice President
Group Sector Head – Built Environment
TATA Consulting Engineers Limited

Flood Management in Built Environment

Dr. H. A. Kazmi
Advisor, RODIC Consultants Pvt. Ltd.
Erstwhile Regional Head (India & Bhutan),
SMEC International Pty. Ltd.

Introduction

India is highly vulnerable to floods. Many Indian cities are experiencing more intense and frequent seasonal floods since 2000. Historically, flood damages have steadily increased despite the best mitigation efforts. Urban floods are mainly man-made disaster.

According to the Ministry of Housing and Urban Affairs (2021) in India out of the total population of 1210.2 million as on 1st March, 2011, about 377.1 million are in urban areas. The net addition of population in urban areas over the last decade is 91.0 million. At the current rate of growth, urban population in India is estimated to reach a staggering 575 million by 2030.

The rapid rise in the Built-Environment, while it helps to improve the standard of living of people living in urban areas due to invention of new technologies but it is also disturbing the environment, especially the water bodies, lakes, rivers, and coasts. Expansion of urban areas resulted in reduction of water bodies, waterways, river regime, lake shores and sea coasts leading to flooding in urban and even semi-urban areas.

Urban flooding is significantly different from rural flooding as urbanization leads to developed catchments, which increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. It is not only the event of flooding but the secondary effect of exposure to infection also has its toll in terms of human suffering, loss of livelihood and, in extreme cases, loss of life (NDMA 2021).

Climate Change and unplanned urban growth have caused increasing trend of urban flooding which has become a universal phenomenon and it poses a great challenge to urban planners and water resources engineers. The world has witnessed that cities are being inundated from hours to several days causing temporary relocation of people, damage to public facilities and essential services, losses of lives and properties, disruption in transport, water supply, power, communication and followed by incidence of epidemics, deterioration of water quality and other risks.

Urban floods have attained the status of disaster due to high vulnerability and risks. How can the cities prepare to become more resilient in this erratic future so that urban dwellers, urban property and infrastructure are protected from the devastating impacts of rain and floods they are facing. Flood management and proper planning of land use for built environment have to be accorded top priority.

Causes of Floods

Floods are results of both natural causes and man-made factors. There are many different causes leading to flooding. Some of the main ones among them include:

Heavy Rainfall and Uncertain Storms: Global climate change is causing changes in weather pattern and frequent occurrence of high intensity rainfall which further aggravates the risk of flooding in towns and cities.

Rise in River Bed: Rivers especially the Himalayan rivers carry a large load of sediments due to steep gradients. The silt and sand are ultimately deposited in the river bed, on river shores and in the catchment area, resulting in reduction of the water carrying capacity of the river and this causes the spilling of rivers over their natural banks.

River Meandering: In the flat terrain rivers have the tendency to meander or change the course within a specific boundary. River meandering is an inherent characteristic of drainages in an alluvial plain like the lower reaches of the Gangetic plains and Brahmaputra.

Inadequate Storm Water Drainage System: Most of the underground drainage facilities within core clusters of the mega cities are usually a century old antiquated brick masonry conduits with structural failures. Drainage systems in most flood prone urban areas are not functioning up to capacity and there are insufficient number of water retention areas.

Unplanned Urbanization: The level of damage and vulnerability of an urban area is directly proportional to the density of development in that settlement. Overburdened drainage infrastructure, unregulated, and unplanned construction without regards to the hydrology, topography, and geomorphology in an urban area increases the flood risk (Hari Ilam Vazhuthi, 2020). Lasting irreversible damage has been done to the city by property builders, property owners, and public agencies by flattening the terrain and altering natural drainage routes.

Paving the way for Floods: Rainwater infiltrates into soil surface, flows as surface runoff and evaporates from open water bodies into the atmosphere. As cities grow buildings and roads are constructed on open spaces and natural ecosystems. Areas which absorbed rainwaters are replaced by hard, impermeable surfaces which increases the volume and speed of runoff and those then cause frequent flooding.

Interference in Drainage System: Public infrastructure (bus depots, roads, metro rail, airports, etc.) are often located on low-lying areas (floodplains, lake beds) and face increased flood risk. Interference in drainage systems caused by badly planned construction of bridges, roads, railway tracks, canals, etc. hampers the flow of water and the result is flood.

Cloudburst: Cloud bursts lead to a high amount of rainfall within a short time leading to flash floods, which generally occur in the Himalayan region.

Cyclones: Tropical cyclones accompanied by strong winds, high tidal bores cause inundation of coastal regions. Cyclone generated sea waves of abnormal height spreads the water in the adjoining coastal areas. Floods due to cyclone are common in the East coast of Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. In recent years storms have also been occurring in the Arabian Sea and affecting the west coast of India.

Failure of Dams & Sudden Opening of Gates: A catastrophic failure of the dam can release the water within a periods of minutes to at times days causing extreme downstream flooding. Mismanagement of reservoirs in several cases of have caused floods due to the sudden opening of the gates of dams to prevent overtopping of the dam have become another feature and affect all the habitations which have sprung up on the downstream side.

Deforestation: Deforestation is also a major cause of man-made flooding. Deforestation causes more soil erosion, reduced infiltration thus high runoff which raises the water level in rivers.

Climate change: The climatic changes caused due to human practices also add to the risk of flooding. Human beings cut trees in a large number, thus affecting the process of photosynthesis. The increased level of carbon dioxide in the atmosphere causes changes in the climate, posing threats of natural disasters like floods, etc. The Global warming results in snowmelt which leads to synchronization of runoffs from various parts of the watershed causing floods.

Impacts of Floods & Damage Assessment

Despite decades of research in India and internationally, assessment of flood loss is still a challenging task. One of the major constraints in India is availability of the data. Recent studies have identified a number of major problems. One of these is identifying "the specific damages seen as significant under the circumstances".

Immediate impacts of flooding can include loss of human life, damage to properties (both private and public) and infrastructure, and destruction of environment. Examples of long-term impacts include the interruption to communication networks and critical infrastructure (such as power plants, roads, hospitals, etc.) that can have significant impacts on social and economic activities.

As per Merz et. al. (2010) some examples of the different types of damage are:

• **Direct, tangible:** damage to private buildings and contents; destruction of infrastructure such as roads, railroads; erosion of agricultural soil; destruction of harvest; damage to livestock; evacuation and rescue measures; business interruption inside the flooded area; clean-up costs.

• **Direct, intangible:** loss of life; injuries; loss of memorabilia; psychological distress, damage to cultural heritage; negative effects on ecosystems.

• **Indirect, tangible:** disruption of public services outside the flooded area; induced production losses to companies outside the flooded area (e.g. suppliers of flooded companies); cost of traffic disruption; loss of tax revenue due to migration of companies in the aftermath of floods.

• **Indirect, intangible:** trauma; loss of trust in authorities.

Flood damages include all detrimental effects on people, their health, and properties; on public and private infrastructure, supplies, ecological systems, cultural heritage, and economic activities. The consequences of flooding for people are more complex and must be considered in post evaluation.

Flood Loss Assessment Process and Methods

Flood damage assessment can be (1) Rapid or Initial Assessment During the Flood, (2) Early Recovery Assessment, or (3) In-depth Assessment or Detailed Assessment (APFM 2013).

1. Rapid/Initial Assessment During the Flood

The purpose of assessment during a flood is mainly to have a factual basis for emergency response and relief coordination, to have an understanding about the overall flood situation, its impact and consequences, and to come up with a set of policy recommendations to address attendant issues in the post-event phase. The focus of assessment during this phase is placed on emergency response rather than loss assessment. A Rapid/ Initial Assessment guidance material is provided in IASC (2018), (IASC, (2012), Bhatt et. al. (2005) and ADPC (2000).

2. Early Recovery Assessment

In the immediate aftermath of a flood event, i.e. 1-3 weeks after the flood (peak), the purpose of an "early recovery" assessment lies in guiding the recovery process and in providing early indications for reconstruction in particular with a view to facilitate repair key infrastructure, the develop of financial mechanisms for speedy recovery, priorities setting in allocation of recovery assets.

UNECLAC (2003) has provided a standard and internationally accepted methodology for estimation of socio-economic and environmental losses. The underlying methodology is based on (i) physical assets that will have to be repaired, restored, replaced or discounted in the future

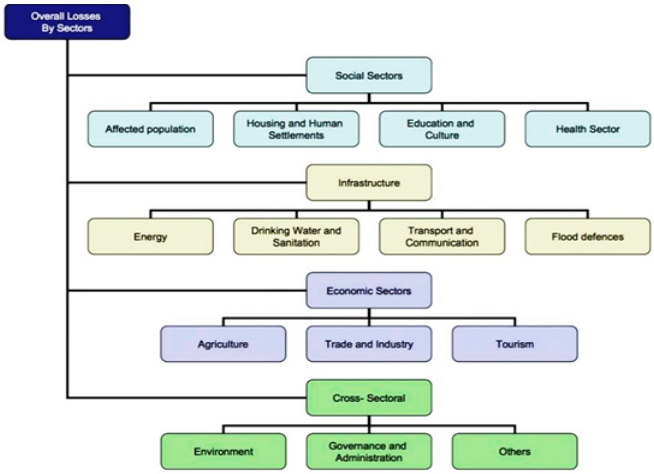

Figure 1: Disaggregation of losses by sectors (UNECLAC, 2003)

and (ii) flows that will not be produced until the asset is repaired or rebuilt. The UNECLAC methodology further conducts the assessment on a sectoral basis, similar to the framework displayed in Figure 1.

Considering presently available methodologies, it is advisable to base assessments on actual costs and damages, that is, replacement cost – how much it would cost to replace the assets and income lost based on their original specification and location.

3. In-depth Assessment/ Detailed Assessment

An in-depth assessment of the full economic impact of a flood event can only be reliably conducted 3-6 months after the event. Perhaps the best time to conduct an in-depth assessment of flood losses is after 6 months because by that time most losses, including indirect and intangible losses, can be assessed with sufficient reliability. During this period a flood loss assessment is necessary to guide reconstruction planning as well as adjustments in future flood management policy. Figure 2 provides a general process of flood loss assessment in 12 steps and a detailed description of each step is provided in the The Loss Assessment Process (EMA 2002). The detailed process is presented in EMA (2002) and types of reports and its format are described in ADPC (2000).

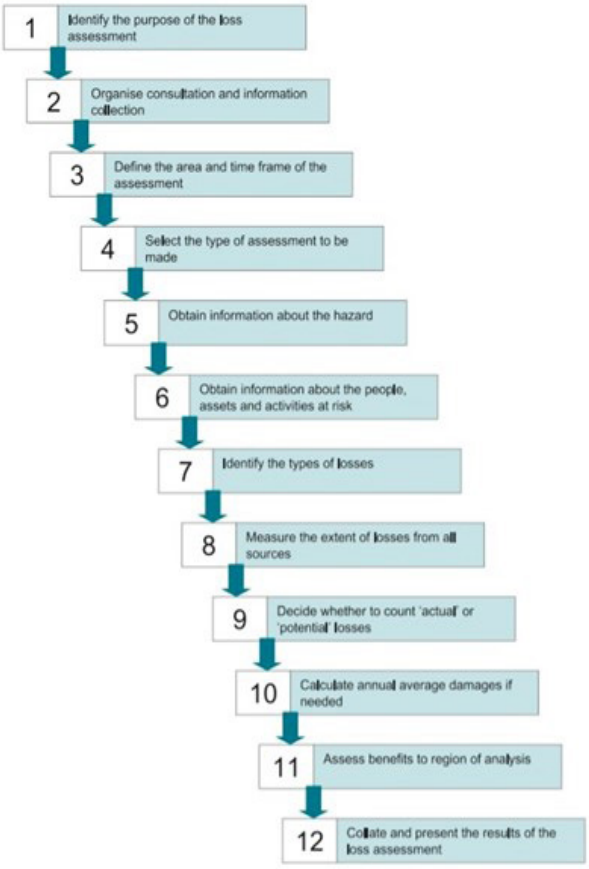

Figure 2: The Loss Assessment Process (EMA, 2002)

Flood Management

The main government response has been to construct more infrastructure rather than significantly improve water management, data collection and land-use planning. The climate change makes it imperative for Indian cities to prepare. It's necessary for governments to invest in infrastructure, improve water management, data collection and land-use planning. If that is not done now, the damage may cost a lot more in the future in terms of lives and the built and natural assets.

An Integrated Flood Management plan should address the key elements that follow logically for managing floods as listed below:

1. Strengthening the Planning Process

Master Plans of cities are prepared by development authorities of the city concerned e,g. Chennai Metropolitan Development Authority, Mumbai Metropolitan Region Development Authority (MMRDA), Delhi Development Authority (DDA), Kolkata Metropolitan Development Authority (KMDA). These organisations mostly have architects, planners and civil engineer (for infrastructures). There should also a be Flood Planning Department within these authorities headed by an experienced Hydrologist.

The problem starts at the planning stage when the necessary considerations are not given to manage a flood exceeding the design standard flood. Master Plans must clearly identify areas to be earmarked for flood storage and these must be sacrosanct in order to protect critical areas and infrastructures in extreme flood situations. Land-use planning and water management should be combined in one integrated plan with a certain common field, such as the mapping of flood hazards and risks, to enable the sharing of information between land-use planning and water management authorities. Vulnerability analyses and risk assessments should be part and parcel of city master plans.

Planners must adopt Sponge Cities Concept to make cities more permeable so as to hold and use the rain water which falls upon it. The retained water then gets naturally filtered by the soil and can be allowed to recharge the urban aquifers. The water stored in aquifers can easily be treated and used for city water supply in dry seasons. New porous materials and technologies must be adopted, encouraged and mandated. Bioswales can be planned along roadsides. Bioswales are channels designed to collect and convey stormwater runoff while removing debris and pollution. Bioswales can also be beneficial in infiltration of water and recharging groundwater. Permeable material for roads, sidewalks, drainage systems and water retention systems including Rain Water Harvesting (RWH) in buildings which allow storm water to infiltrate into the ground.

2. Effective Institutional Arrangement

Despite India's frequent cycle of floods and droughts, its approach to water management has always been piecemeal. Whenever a disaster hits, committees are set up, but they soon disappear, leaving no institutional memory. The absence of a single water agency and a national water law are other major challenges.

In India, there exists a three-tier system of flood management: Central Government, State Government and Local Urban Bodies. The works of all the governmental agencies tasked with water management are uncoordinated and done in a piecemeal fashion. Besides, there is inadequate institutional capacity for enforcement of flood management in the urban areas.

The Government of India agencies related to flood management include: Central Water Commission (CWC), National Disaster Management Authority (NDMA), Indian Meteorological Department (IMD), Brahmaputra Board, The Ganga Flood Control Commission (GFCC),

Farakka Barrage Project Authority. The Government of India framed The National Water Policy of 2012 which has laid significant emphasis on the management of floods. NDMA (2010) has prepared a National Disaster Management Guidelines- Management of Urban Flooding.

State Government agencies include: State Disaster Management Authority, State Irrigation/Water Resources (& Flood Control) Departments, State Flood Control Boards/State Flood Control Technical Advisory Committees, State Public Health Department/Water Boards, Sate Public Works Department.

The City Level Administration includes Municipal Corporations, District Disaster Management Authority, Development Authority and Cantonment Boards.

For preparation of an effective flood management plan, detailed documentation related to the whole of the natural boundaries of the watershed areas should be held by agencies which are beyond municipal jurisdictions.

3. Implement of Mitigation Projects

Projects that focus on improving stormwater management or reducing flood risk from a major river can be effective ways to mitigate flooding. These projects include traditional and innovative practices and can consist of levees, floodwalls, impoundments, improved conveyances, wetland restoration, acquisition of flood-prone properties and even stormwater harvest and reuse.

Structural Measures

Dikes to protect overtopping of the riverbank and overland flow from surrounding areas: These include embankments, floodwalls and ring bunds, river training works such as spurs and revetments to arrest bank erosion, pumping stations, drainage tunnels and pipes, dredging and widening of sewage canals, improvement of the river channel, retention area and flood control reservoirs, flood control centre.

Constructing drainage system within urban areas to drain water to the river: The system consists of: Rejuvenation of water bodies, restoration of original drainage system, improving drainage pipes, drainage canals, constructing drainage tunnels in area where the drainage system is insufficient, constructing water gates, constructing pumping stations, constructing water retention areas, and construction of raised platforms to be used during times of flood emergency.

Catchment area measures: Afforestation of the catchment areas of the rivers causing flooding, building of storage dams across those small streams, which have devastated large areas in the past, desolation of those reaches of the rivers course and drainage channels which obstruct the free flow of floodwater, and straightening of the meandering river channels.

Implement Geographic Information Systems (GIS): Basically, databases of infrastructure and natural resources of the urban areas are developed on GIS to document historic and existing conditions of stormwater management systems and natural streams alike. The database can serve as the foundation for hydrologic and hydraulic modelling and assist in assessment of flood damages.

Installing Information System: Establishment of proper flood warning systems, radar for rainfall monitoring, rainfall forecast system, automatic rainfall monitoring system, automatic monitoring system on flooding on roads and highways, automatic monitoring system on water in canals, automatic monitoring system on the operation of pumping stations and gates

Mumbai, a state-of the-art Integrated Flood Warning System called "iFLOWS" was launched in 2020. The Decision Support System would enable smart decision-making and field action based on risk assessment. For all these it is imperative that the persons concerned be qualified, have adequate requisite experience and are appropriately trained to be able to carry out their duties responsibly.

Non-Structural Measures

Flood fighting, land use control, public information, training and education. A convergent approach should be adopted effectively through an urban mission along the lines of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), National Heritage City Development and Augmentation Yojana (HRIDAY) and Smart Cities Mission.

4. Manage the Water Cycle as a whole

Flood management plans should take a holistic approach to exploring the possibilities for accelerated artificial recharge under given geological conditions. Integrated Flood Management should focus on managing all the phases of the water cycle as a whole. The urban water cycle is 'man made' created to provide drinking water to homes, businesses, industries, to remove wastewater and sewage, and redirect stormwater away from point of discharge and into designated waterbodies or waterways. Groundwater and surface water should be considered as linked resources, and the role of floodplain retention capacities for groundwater recharge should be factored in.

5. Integrate Land and Water Management

According to WMO (2009) the hydrological responses to rainfall strongly depend on the local characteristics of soil, such as water storage capacity, infiltration rates and preceding rainfall conditions. Human alterations to catchments can play a significant role in increasing flood hazards if the runoff generation process is changed, especially when the infiltration capacity of the soil decreases or a change in soil cover occurs. Upstream changes in land use can drastically change the characteristics of a flood and the associated water quality and sediment transport characteristics, especially conversion of forested areas and wetlands into other landforms. Upstream urbanization as well as river training can cause an accentuation of flood peaks and their early occurrence in downstream reaches. Flood management needs to recognize, understand and account for these linkages in order to realize the synergies in improving river basin performance. Taking advantage of these potential synergies would, however, require the wider perspective of the development of the river basin in its entirety. Attempting to resolve local problems in an isolated manner is no longer a viable strategy, if it ever was. (WMO 2009).

6. Manage Risk and Uncertainty

Flood risks are also related to hydrological uncertainties. Knowledge of these at present is incomplete and generally there is an imperfect understanding of the causal processes in operation. The extent of future changes cannot be predicted with certainty. Uncertainty and risk management are defining characteristics of choice, and risk management is a necessary component of the development process, essential for achieving sustainable development. The application of a risk management

Strategy	Options
Reducing Flooding	• Dams and reservoirs • Dikes, levees and flood embankments • High flow diversions • Catchment management • Channel improvements
Reducing Susceptibility to Damage	• Floodplain regulation • Development and redevelopment policies • Design and location of facilities • Housing and building codes • Flood proofing • Flood forecasting and warning
Mitigating the Impacts of Flooding	• Information and education • Disaster preparedness • Post-flood recovery • Catchment management • Flood insurance
Preserving the Natural Resources of Flood Plains	• Floodplain zoning and regulation

Table 1. Strategies and Options for Flood Management (WMO 2009)

approach provides measures for preventing a hazard from becoming a disaster. Risk management calls for identification, assessment, and minimization of risk, or the elimination of unacceptable risks through appropriate policies and practices. Flood risk management also includes the efforts to reduce the residual risks through such measures as flood-sensitive land-use and spatial planning, early warning systems, evacuation plans, the preparations for disaster relief and flood proofing and, as a last resort, insurance and other risk sharing mechanisms (WMO, 2009).

7.Adoption of the Best Mix of Strategies

Three linked factors determine which strategy or combination of strategies is likely to be appropriate in a particular river basin: the climate, the basin characteristics and the socio-economic conditions in the region. Table-1 shows the strategies and options generally used for flood management (WMO 2009).

8. Engage Communities and follow a Participatory Approach

Integrated Water Resources Management including flood management should involve the participation of local communities, water users' associations, NGOs, planners, policymakers, elected members and enforcement officials at all levels. The participatory approach should include public consultation and the involvement of all these stakeholders both in planning and implementation. To make a system sustainable, representatives of all the upstream and downstream stakeholders are required to be involved in decision-making process.

To increase the city's resilience to floods, it is critical to enhance the preparedness and response capacity of local communities, especially the urban poor. It's important for people living in flood prone areas to be ready should a disaster occur, hence they should be apprised of the following:

• Knowing the risks
• Preparing the property before the cyclone season
• Having an emergency plan for themselves and their family and pets
• Having an emergency kit with at least 3 days of supplies
• Knowing the evacuation routes

The residents should be encouraged and visitors must follow the Plan, Pack., Listen approach.

• Plan: Make an emergency plan
• Pack: Pack an emergency kit
• Listen: Stay informed

9. Adopt Integrated Hazard Management approaches

The Integrated Hazard Management approach includes development of concerns along with emergency planning, prevention, recovery and mitigation schemes, and offers a better treatment of common risks to life, as well as more efficient use of resources and personnel. It consequently ensures consistency in approaches to natural hazard management in all relevant national or local plans. Early warnings and forecasts are key links to the series of steps required to reduce the social and economic impact of all natural hazards, including floods. To be effective, however, early warnings of all forms of natural hazards must emanate from officially designated authorities with a legally assigned responsibility (WMO 2009). NDMA (2021) has recommended Do's & Don'ts for Urban Floods, which are worth adopting.

Conclusions

Many Indian cities are experiencing more intense and frequent seasonal floods since 2000. Historically, flood damages have steadily increased despite mitigation efforts. There has been an increasing trend of urban flood disasters in India over the past several years whereby major cities in India have been severely affected.

The paper examined causes of major floods in India which are the results of both natural causes and man-made factors. Climate change has played an important role in causing large-scale floods across central India. There are numerous instances where floods were caused by dam failure or its improper management. A major problem is the inaction on recommendations of evaluation reports, institutional failure due to non-operational disaster management plan and lack of coordination between various central government, state government agencies and local urban bodies. There should be a single institution that bears an overall responsibility and accountability of the management of the flood water system within cities.
A systematic review of the impact of urban floods and damage assessment has been presented. There decades of research in India and internationally, assessment of flood loss is still a challenging task. One of the major constraints in India is availability of the data. Recent studies have identified a number of major problems. One of these is identifying the specific damages seen as significant under the circumstances.

Flood damage assessment can be (1) Rapid or Initial Assessment During the Flood, (2) Early Recovery Assessment, and (3) In-depth Assessment or Detailed Assessment. Flood damages can be classified into direct and indirect damages. Both types of damages could be further classified into tangible and intangible damages, depending on whether or not they can be assessed in monetary values.

The main government response to flood management has been to construct more infrastructure rather than significantly improve water management, data collection and land-use planning. Experts have criticized the plans for focusing too much on hard infrastructure solutions which they say are costly and would never be adequate. It's necessary for governments to invest in infrastructure, improve water management, data collection and land-use planning. If that is not done now, the damage may cost a lot more in the future.

research and planning of flood management, which need to include both long-term and short-term interventions.

An internationally accepted Integrated Flood Management Approach for logically managing floods has been highlighted. Planners must adopt Sponge Cities Concept to make cities more permeable so as to hold and use the water which falls upon it. New porous materials and technologies must be adopted, encouraged and mandated. Permeable materials for roads, sidewalks, drainage systems and water retention systems including Rain Water Harvesting (RWH) in buildings which allow storm water infiltration into the ground are required. Integrated Urban Flood Management practices would not just help control recurring floods but also provide for water security, more green spaces, and would make the city resilient and sustainable. The sustainable development requires the involvement of the communities especially those who are affected or living in flood prone areas at all levels of decision-making and implementation.

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NEWS

THE WEATHER CHANNEL
ENVIRONMENT

Mumbai Launches Its Climate Action Plan; Becomes the First Major City in India and South Asia to Do So

By IANS

less than an hour ago (28 th August 2021)

TWC India

Mumbai, a city that is at high risk of facing the recurring onslaught of extreme weather events, including cyclones, has become the first big city in India and South Asia to launch its Climate Action Plan.

Aimed at better future planning and growth, keeping in tune with climate adaptation, mitigation and resilience, the Municipal Corporation of Greater Mumbai (MCGM) is developing the Climate Action Plan to be completed after public consultation in two months' time.

Maharashtra Minister of Environment, Tourism and Protocol, Aaditya Thackeray, launched the Climate Action Plan along with the Mumbai Climate Action Plan (MCAP) website on Friday, so as to seek suggestions and inputs from experts and citizens from the megacity. The event took place in Mumbai and several people from across the state and outside attended it virtually.

Urban Flood Management

S. K. Mazumder
AICTE Emeritus Fellow and Professor of Civil Engineering
Delhi College of Engineering/Delhi Technological University
(DCE/DTU)

1.0 INTRODUCTION

Most of the civilizations in the world have come up by the side of rivers, since they are a source of water for municipal and industrial consumptions and also act as drainage channels for disposal of storm run-off and waste water. Floods occur when the inflow into a river exceeds its carrying capacity. Floods are area specific and hence the cause of floods must be investigated thoroughly before adopting flood protection measures – be it in rural or built up areas. Floods cause not only loss of life and properties; they also bring in their wake unimaginable sufferings for the people - especially those living within the flood plains. Urban flood management including flood protection and flood forecasting/ warning are of great importance to save lives and properties by adopting precautionary measures before the occurrence of floods.

In this paper some of these aspects are discussed with special emphasis on flooding of built up areas in India.

2.0 FLOOD DAMAGE

The Rashtriya Barh Ayog (RBA 1987) estimated that the total area liable to floods in India as 40 Mha. Subsequently, the extent of maximum area affected in a year by floods has been updated by XII Plan Working Group on Flood Management and Region Specific Issues as 49.815 Mha. As per data base maintained by CWC (1979), the highlights of flood damage during the period from 1953 to 2016 are given in Table 1.

Table-1 Flood Damage in India (1953-2017)

Item	Average Annual	Maximum (Year)
Area Affected (Million Hectare)	7.51	17.50 (1978)
Crop Area Affected (Million Hectare)	3.65	10.15 (1988)
Population Affected (Rupee crore)	3.29	7.045 (1978)
Human Lives Lost (Nos.)	1601	11,316 (1977)
Cattle Lost (Nos.)	92,828	6,18,248 (1979)
Houses Damaged (Nos.)	12,17,461	35,07,542 (1978)
Value of damage to crops (Rupee crore)	713.25	4,246.62 (2000)
Value of damage to house (Rupee crore)	279.86	1,307.89 (1995)
Value of damage to public utilities (Rupee crore)	825.45	5,604.46 (2001)
Value of damage to crops, houses & public utilities (Rupee crore)	1,818.56	8,864.54 (2000)

Apart from the tangible damages given above, floods result in unimaginable human miseries/ sufferings due to loss of their abodes and goods, lack of communication, water borne diseases, etc. Photos 1 and 2 illustrate the flood furies in Bihar and West Bengal after breach of flood embankments. The recent floods in Europe due to intense rainfall paralysed the life in many cities there. As a result of significant changes in weather patterns due to climatic changes, recent extreme

precipitation in different parts of the world far exceeded the design capacities of local protection infrastructures and systems – resulting in massive flooding, casualties, and economic losses. In mid-July. the German regions of Rhineland-Palatinate and North Rhine-Westphalia saw 148 litres of precipitation per square metre falling within a period of 48 hours with 154 mm of rain in 24 hours. That was 170 per cent higher than the previous record when usually that area received about 80 litres in the whole of July (Photo-3).

Floods due to cyclonic storms have been causing loss of life and properties in the coastal areas. Recently the Ratnagiri area in Maharashtra and the Sundarban areas in West Bengal. Some years ago Kedarnath town was washed out (Mazumder, 2014) resulting in instant death of about 3000 persons due to a Glacial Lake Outburst Flood (GLOF) in the Mandakini

Photo-1: Devastation in Bihar brought about by River Kosi due to Breach in Left Flood Embankment about 12 km upstream of the Kosi Barrage

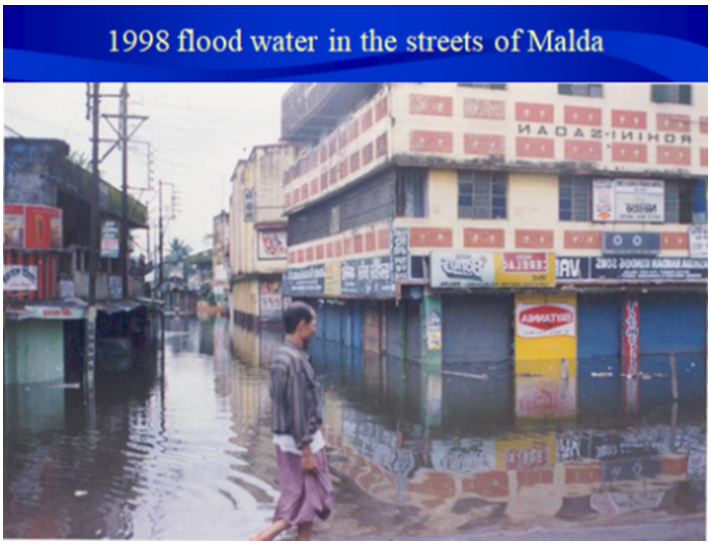

Photo-2: Flood in Malda Town due to Breach of Left Marginal Flood Embankment in River Ganga U/S of the Farakka Barrage

Photo-3: Showing flooding in Erftstadt Germany. Rhein-Erft District in July 2021

Photo-4: Washout of Kedarnath Town, Uttarakhand due to GLOF in Mandakini River in 2013

River in the year 2013 (Photo-4) .Chamoli Valley flood in the Rishiganga River in Uttarakhand (Mazumder, 2021) also caused loss of life and severe damages to hydro-power projects and roads in March 2021.

3.0 FLOOD INVESTIGATION

All floods are area specific. It is, therefore, extremely important to investigate the exact cause of the flood. The main causes of floods in India are:

(i) High intensity rainfall in a short duration

(ii) Poor or inadequate drainage/ channel capacity

(iii) Unplanned reservoir regulation

(iv) Aggradation and degradation of rivers, river meandering and river avulsion

(v) Failure of flood control structures, e.g., dams, barrages, flood embankments, etc.

(vi) Cyclonic storms in the Arabian Sea and the Bay of Bengal, and

(vii) Glacial Lake Outburst Flood (GLOF)/ Landslides/ Avalanches.

Any flood control measure without proper investigation of the cause of flood is likely to be ineffective and would be a wastage of resources apart from money.

4.0 FLOODS IN URBAN BUILT UP AREA

As already mentioned, most of the cities/ towns are built by the side of rivers/ streams principally for easy access to a water source and drainage of storm and waste waters. Intense and prolonged rainfall in the catchment area of these rivers/ streams often result in high run-off causing high flow and rise in flood level in the river/ stream. When the flood level exceeds the natural bank level, the flood waters spill over the bank and resulting in flood and consequent damage. Flood embankments are built on low level banks for protection of the cities/ towns against flood fury. Breach in the embankment is responsible for sudden and severe floods in the adjoining areas as illustrated in Photos 1 & 2. Embankments are also responsible for drainage congestion in urban areas unless properly designed gated sluices are provided to permit run-off generated in the urban catchment to drain into the river. The most affected are the poor people who live in the flood plain areas behind the embankment in the countryside.

Drainage congestion in cities/ towns occurs also due to inadequate or improper provision of the drainage system. The drainage network (mostly for flow by gravity) have to be designed such that their carrying / conveyance capacity is equal to or more than the inflow run-off at any point of the system at any point of time. Time of concentration and the corresponding rainfall intensity of design return period have to determined scientifically at all points wherever a change in section or a junction occurs since flow in drains are spatially varied. Any arbitrary method adopted to determine the design rainfall is one of the principal causes of flooding/ waterlogging in most of the urban drainage systems in India. The Guidelines for Urban Drainage (HEC-22; ASCE,92) prescribes use of rational formula (Q=0.028fPIc A) for determination of design flood discharge (Q) based on design rainfall intensity (Ic) in the catchment area (A) having run-off coefficient, P. The current practice being followed in

finding design rainfall intensity is as per IRC:SP:50-2014. The design intensity being adopted in some of the metropolitan cities in India are given below:

Delhi: (i) Internal Drains: 1cusec/acre, (ii) Intercepting Drains: 0.75 cusec/acre, and
(iii) Main Drains: 0.5 cusec/acre

Mumbai: Critical intensity of rainfall: 50 mm/hour (Frequency of storms: 2times a year)

Chennai: Critical intensity of rainfall: 25mm/hour (corresponding to a duration of 1 hour with 1.25 year return period.

Rainfall intensity (Ic) corresponding to the Time of Concentration and Frequency/ Return Period should be found scientifically for computing the drainage discharge. Mazumder [2017(a)] outlined different methods of finding design rainfall intensity by Rational and other methods for computing design flood for drainage design in built up areas.

Another important aspect of drainage design is the hydraulic condition at all outfall points for mains, branches and tertiary drains. When the main drain joins a river/ stream, the drain flows freely only when the drain water level is higher than the flood level of the river/ stream. In a flat terrain, however, situation arises when the peak flood level is higher and the outfall may be submerged. Up to a given limit of submergence (also called submergence limit), drains may discharge freely. Once the submergence limit is exceeded, it is submerged flow when the co-efficient of discharge (Cd) in the flow formula (Q=Cd L H3/2 for weir type control) reduces as explained in IRC-SP-13 (2020) and Mazumder (1981). In the formula Q is flow rate, L is the effective length of weir, and H is the head above the crest. At 100% submergence, Cd is zero and hence Q=0 causing drainage congestion in the city area and water from the river would backflow into the city area. In such situations, drain water at outfall must be pumped into the river by construction of suitable sumps equipped with pumps.

5.0 URBAN FLOOD MANAGEMENT

Floods are natural phenomena except the situations which involve failure of the flood control structures or faulty regulation of reservoirs. Permanent immunity against floods is not techno-economically feasible. However, impacts of floods can be mitigated to a certain degree by adopting appropriate structural and non-structural measures as briefly discussed below. The loss of lives, property, goods, working hours and the financial as well as economic losses in the recent floods in Mumbai in Maharashtra and Sunderban areas in West Bengal could be far more than the cost of any permanent solution of flood control.

5.1 Structural Measures

Some of the structural measures of flood control are:

5.1.1 Construction of Reservoirs

Reservoirs built on rivers (e.g. Govindsagar, Hirakud, Narmada sagar, Nagarjun sagar, Panchet, etc.) help in absorption of flood and lowering of peak flood by temporarily storing water in the space between FRL and MRL(surcharge space).

In recent times it's the reservoirs that have become the cause of flooding the downstream areas because the reservoir water is let out with all gates opened. Better rainfall prediction and reservoir level monitoring and flood prediction would go a long way to minimise and even prevent such instances.

5.1.2 Detention basins/Check Dams

Dams cannot be constructed in the lower reach of a river in flood plains. However, Detention basins [Mays,2012& 1999; Mazumder,2017(b)] for temporary storage of storm water can be built at the tail end of an urban drainage system for absorption of run-off from city catchments such that the flood level of river remains unaltered before and after the development of the city as shown in Figure-1.

Besides controlling flood, such storages are useful in recharging ground water, pollution control, fish culture, recreation etc. Check dams in steep channels are found to be highly effective in reducing peak flood in urban areas.

5.1.3 Flood Embankments

As stated earlier, flood embankments are preventive measure of flood control. However, they are costly and need regular maintenance and constant vigil. Without dykes (embankments), Netherlands would be submerged, since most of it is below sea level.

5.1.4 River Improvement

All rivers especially in plains are found to meander and silt up thereby reducing the carrying capacity /conveyance of the rivers with time. River improvement works e.g. dredging, meander control works, etc. (CBIP, 1989; Mazumder, 2010; IRC-89) help in restoration of conveyance and thereby lowering of flood level in rivers flowing by the side of urban/ built up areas.

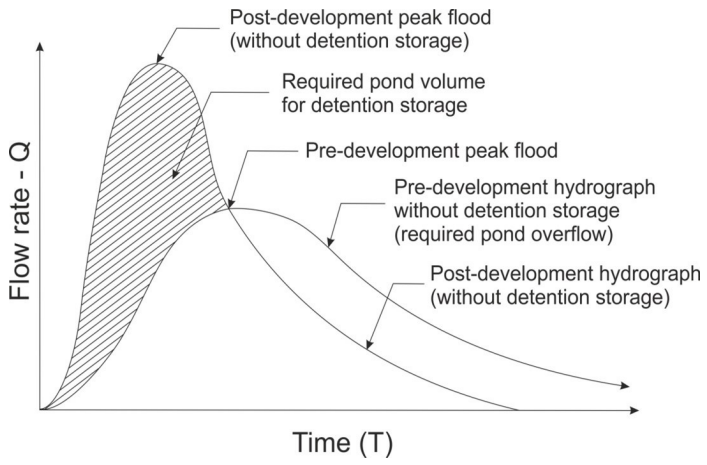

Figure-1 Illustrating Detention Storage Volume(Shaded Area)

Needed to Bring Post Development Peak Flood to Pre-Development Peak in Urban Areas

5.1.5 Drainage improvement

One of the major causes of waterlogging in built up areas is inadequate and unscientific drainage design as discussed under Section-4 above. Stormwater drainage should be separate and not combined with sewerage

often resorted to for cost reduction. Apart from pollution of river water, combined drainage cause choking and loss of carrying capacity of the sewer.

5.1.6 Diversion of Flood Waters

Flood flow at any point/ stretch of a river should not exceed the carrying capacity/ conveyance of the river/ channel at that point/ stretch. Diversion of excess flow through diversion channels is effective in controlling flood and flood level. Flood in Mississippi and Missouri rivers was controlled (CWPC,1962) substantially through such flood diversion at suitable locations. NWDA, under the Ministry of Jalshakti, Government of India, proposes to interlink Indian rivers (IWRS,1996) by constructing 30 link canals connecting Indian rivers for diversion of excess flood water from surplus basins to deficient basins for food security and partial flood relief. Apart from flood relief, such flood diversions would be effective in recharge of ground water.

5.2 Non-Structural Measures

Structural measures of flood management discussed under section 6.1 are costlier compared to non-structural measures e.g. rainwater harvesting, soil and forest conservation, flood forecasting, etc. which are discussed briefly in the subsequent paragraphs.

5.2.1 Rain Water Harvesting

Surface run-off in built up areas can be substantially reduced by collection and diversion of run-off from roofs, lawns, drains in to recharge pits which helps in recharge of ground water (IRC:SP:42, 2016).

5.2.2 Soil and Forest Conservation

Erosion of soil and lack of vegetative cover in the catchments area is responsible for generation of high run-off, which causes floods in two ways. Firstly, it increases flood volume due to loss in infiltration rate and secondly the eroded soil causes sedimentation of rivers and reservoirs thus causing loss of carrying capacity/ conveyance of the river and storage capacity of the reservoirs.

5.2.3 Flood Forecasting

Loss of life and properties can be reduced substantially through flood forecast and warning ahead of the occurrence of flood event. Accuracy of forecast is extremely important to avoid inconvenience and hardships to the public. Most reliable forecast is river forecasting in which flood levels at different stations along the river are done by river gauge to gauge correlation. However, the Lead Time (the time between forecast and actual flood event at a site) is less compared to the hydrologic forecast through hydrologic modelling of the catchment. The maximum lead time is available from meteorological forecast. However, reliability of forecast is maximum in the River Forecast and least in the meteorological forecast. It is, therefore, important to use all the methods successively to improve the quality of forecast and its reliability. Flood Forecasting and Flood Warning in India was commenced in a small way in the year 1958 with the establishment of a unit in the Central Water Commission, New Delhi, for flood forecasting for the river Yamuna at Delhi. Presently, there are 878 Hydrological and Hydro-meteorological sites being operated by CWC across the country covering 20 river basins for gauge, discharge, sediment and water quality observations (Mazumder et al, 2018).

6.0 SUMMARY & CONCLUSIONS

Flood investigation is necessary for determining the cause of flood since flood management and control are area specific. Floods occur in both rural and urban India due to multiple reasons. One of the very common cause of sudden and severe flood resulting in damage to life and properties is breach of flood embankments. Although flood embankments are helpful in direct flood protection, they often result in drainage congestion in city areas due to waterlogging, unless properly designed sluices are provided under the flood embankment. Design of drainage system of adequate capacity depending on incoming flow and continuity of flow should be ensured throughout. Design rainfall intensity of given frequency and concentration time should be determined scientifically to arrive at design flow at all points of the city drainage system. Due consideration with regard to submergence should be made at all outfall points to avoid backflow. In such situations, provisions must be made for sumps and pumps to avoid waterlogging of urban areas. Flood management-both structural and non-structural -have been discussed with emphasis on non-structural ones, as they are less costly and highly effective not only in urban flood management but also for ground water recharge.

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NEWS

INDIA TODAY

News/ World
China to India, floods wreak havoc across the world | See Pics

China to India, floods wreak havoc across the world | See Pics

From China to India, floods have wreaked havoc across the globe. Scroll down to see photos which show scale of devastation.

Deadly floods that have upended life in both China and ermany have sent a stark reminder that climate change is making weather more extreme across the globe.

The death toll in central China's unprecedented flash floods triggered after the heaviest rainfall in 1,000 years has reached 33 with eight people missing, officials told PTI on Thursday. Videos posted on Chinese social media showed petrified passengers trapped in subway trains clinging on to handlebars desperately waiting for help as floodwaters raised up to their necks.

In Europe, climate change is likely to increase the number of large, slow- moving storms that can linger longer in one area and deliver deluges of the kind seen in Germany and Belgium, according to a study published in the journal Geophysical Research Letters.

Torrential rain turned normally placid rivers into raging torrents in parts of Germany, Belgium and the Netherlands, dragging cars and roads with them, bringing down whole houses and leaving more than 150 people dead.

As the southwest monsoon continues to elude parts of India, it is wreaking havoc in parts of Himachal Pradesh and Uttarakhand.

Source:https://www.indiatoday.in/world/story/china-to-india-floods-wreak-havoc-across-the- world-see-pics-1831164-2021-07-22

Managing the Unmanageable: A Flood Modeler's Perspective

Mousumi Ghosh
Ph.D. Research Scholar
Interdisciplinary Program in Climate Studies

Pradip P. Kalbar
Associate Professor
Centre for Urban Science and Engineering

Subhankar Karmakar
Professor & Head
Environmental Science and Engineering Department
Indian Institute of Technology Bombay

Introduction

Floods today are a cause of major concern for most of the parts of our country, be it the rural areas or the urban ones. The onset of monsoon brings a sense of fear and insecurity amongst the people, especially the ones living along the coastline or rivers or large waterbodies due to a rapid increase in severity and unpredictability of high precipitation events. Floods are reported to have the highest damage potential and the most widespread, disastrous, and recurring natural disaster amongst all other forms of natural disasters (Kron, 2005). The year 2020 had witnessed more than ten severe flooding events across the country causing widespread havoc adding to the misery of millions of people in these already challenging times when the entire world is striving to overcome the Corona virus Pandemic. Four out of twenty major coastal cities of the world which are vulnerable to losses incurred during high flooding events, are located in India. The country also has the highest exposure to flooding risk in terms of human lives and GDP due to its peninsular geographic location and substantial rainfall during one-third of a year. Heavy rainfall during the Monsoon months of June to September, natural events such as cyclones accompanied with cloud bursts, landslides resulting in obstruction of flow along river channels, high tides, insufficient capacity, and erosion of riverbanks accompanied with anthropogenic activities are some of the major causes of floods in the country (Kishtawal et al., 2010). The urban areas are more prone to heavy flooding events due to improper drainage networks with low permeability and heavily populated space-constrained regions. With the prolific rise in frequency and intensity of such extreme flooding events, the civic bodies along with the research community, urban planners, and stakeholders have increasingly been involved in adapting efficient flood management strategies to alleviate the adverse impacts. The administration has been actively taking steps for effective flood mitigation and management which has lessened the casualties and economic damage to a great extent over the past decades. However, with the increasing number of such events, there is a need to think of long-term sustainable solutions along with temporary solutions like flood evacuation and shelter homes to increase the preparedness of people towards floods and make the country more resilient to such extremes in the future.

Current scenario of Flood Management in India

The Ganga River basin, the Brahmaputra River basin, the Central India and Deccan rivers basin, and the NorthWest rivers basin are the four major flooding zones in India and are often subjected to flash floods. The Government of India has taken up various initiatives over the decades to make the country more resilient and minimize the vulnerability of people to floods. Several committees, agencies, task forces have been set up at the central as well as state-level from time to time which collectively work together to evaluate the problems associated with floods, and effective management, mitigation, and adaptation. The Central Water Commission (CWC), the National Disaster Management Authority (NDMA), the Ganga Flood Control Commission, the Brahmaputra Board, the Farakka Barrage Project Authority are some of the organizations operational at the national scale which formulate policies and measures and supervise the implementation of flood control programs across the country in the flood-prone areas (Mohapatra and Singh, 2003). The India Meteorological Department which monitors the meteorological observations and issues regular weather forecasts, the National Remote Sensing Center for flood maps also helps in data inventorization to facilitate various studies and research for effective flood management and adaptation strategies. Further, the Flood Control Board, the Water Resources Department, the State Technical Advisory Committee are also some of the organizations which operate at the state level. Several states have set up their task forces and rescue teams for efficient and timely relief and recovery operations in the aftermath of a flood event. For example, from the horrific event in 1999 where the state of Odisha recorded a loss of around ten thousand lives and damages worth 4.44 billion dollars to the state being recognized by the United Nations Agency for Disaster Reduction for its commendable

work towards efficient disaster preparedness in the wake of Cyclone Fani in the year 2019, India's planning, prepardness and response have come a long way.

It is essential to solve the flood damage-related problems through optimal planning and integration of structural and non-structural measures. The development of flood storage structures and reservoirs are some of the structural measures while the non-structural measures include flood inundation and hazard mapping, flood forecasting and warning systems, floodproofing, flood evacuation, etc. (Mohanty et al., 2020a). In the context of cities and urban areas, retention ponds, green roofs, infiltration devices, porous pavements, etc. can be used for flood management (Gogate et al., 2016). Post-independence, several embankment projects have been implemented and reservoirs have been set up for flood protection across the rivers like Mahanadi, Kosi, Lower Damodar, Brahmaputra. However, there still exists a gap in the effective implementation of non-structural measures and needs equal attention for better flood preparedness with the increasing number of extreme events. The states should more proactively work towards flood protection and preparedness measures such as flood risk zoning, floodproofing, flood control, river bed desilting, and drainage development. Measures such as drainage channels, embankments, the establishment of weather and streamflow monitoring stations, and flood forecasting stations are being taken up to increase resilience to floods. Several studies are lately being conducted to analyze the pattern, frequency, frequency, extent, and magnitude of these extreme events and the factors responsible for them. Various research studies are also being conducted to improve the forecast and prediction of these events using statistical techniques and physics-centered models to facilitate the policymakers and administrative authorities for better flood management. There are studies that also evaluated the available flood management options based on various criteria such as technical, economic, social, and environmental such that the prioritization of the stormwater management options can be done. Gogate et al. (2016) recently developed such a framework to evaluate stormwater management options in the context of Indian cities.

The National Water Policy (2012) also suggested creating a data repository of frequency-based flood inundation maps to identify the flood-prone areas, i.e., developing maps of the areas that would be submerged by the rising of a body of water from a well-established watercourse and coverage of surrounding areas resulting from heavy precipitation, cyclones, etc. Modeling of floods before the occurrence of events can help in the generation of flood inundation and hazard maps, obtained by translation of extent and depth of water on land, its duration, and spatial velocity in the extreme rainfall event, which can help in the identification of potential areas at risk. These maps could be disseminated by various agencies among the administrative bodies so that timely action can be taken to minimize the flood risk and damages. User-friendly mobile applications can also play a vital role to provide real-time information on rainfall, flooding to the general public. However, modeling urban coastal floods, especially in developing and underdeveloped countries, is challenging due to lack of reliable long-term data, thriving population resulting in the reduction of natural land, the inadequacy of the existing stormwater drainage network, and high tidal impact.

The research team at the Indian Institute of Technology, Bombay, headed by Prof. Subhankar Karmakar, is striving to develop various scientific technologies, frameworks, and problem-oriented solutions for management and mitigation of such extremes while addressing the aforementioned challenges. Some of the significant studies are Sherly et al., 2015; Patel et al., 2019; Mohanty et al., 2020b; Gusain et al., 2020; and Ghosh et al., 2021. The studies are very generic and can be applied from a regional to a global scale. A recent work by the team has been discussed in the following subsection.

A Case Study of Flood Adaptation Strategy to Evaluate the Performance of Potential Inland Flood Management Options

Under that context, the team developed a novel comprehensive hydrodynamic flood modeling framework to reduce the inundation extent by incorporating different hydraulic scenarios involving various combinations of cross-sections like rectangular and trapezoidal cross-sections and lining materials like gravel and concrete along the river channel (Ghosh et al.,2021). A three-way coupled flood model has been developed in the MIKE FLOOD platform considering all major flood influencers such as rainfall, tidal impact, flows through the channel, overland and storm-water drains to generate flood inundation and hazard maps for the various realistic scenarios. The Mithi river catchment in Mumbai, a highly flood-prone area of the city and subjected to high spatio-temporal variability of rainfall (Ghosh et al., 2021), had been selected to demonstrate the framework (Figure-1). A combination of hydrologic and hydrodynamic modeling was widely implemented for the assessment of flood hazards at a finer scale.

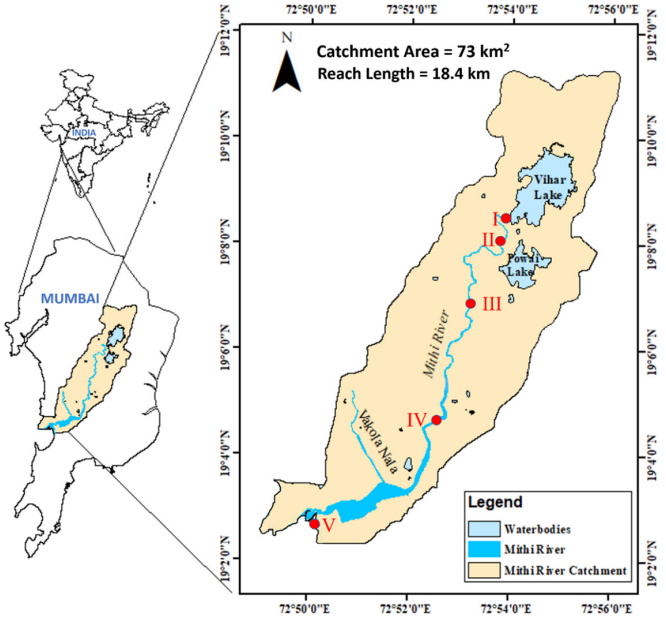


Figure 1: Study area (Mithi catchment) utilized for demonstration of the proposed framework. I to V depicts the change in slope along the catchment (Ghosh et al., 2021)

The hydrologic models help to quantify streamflow in a river channel while hydrodynamic models utilize laws of physics and mathematics to simulate the motion of fluid along the river channel and surrounding areas to replicate the proliferation of flood during and after a rainfall event. The meteorological data like rainfall and temperature, topographical data like the digital elevation details, slope, land-use and land-cover data, hydraulic data like river network and cross-section data, and hydrologic data like streamflow and water levels are essential for assessing the flood characteristics accurately. To overcome the dearth of data required for

the model, alternate techniques were adapted to estimate design rainfall, tidal elevation, and discharge. The problem of lack of dense rainfall monitoring stations was resolved by the application of a single long-term observed rainfall data set by spatially interpolating it over the surrounding climatologically homogenous region. The different return periods of rainfall which refer to the average time between the occurrence of an event of similar intensity was estimated from the long-term time series for 10, 50, and 200-years. Similarly, the absence of long-term observed streamflow data was resolved by simulating it from a hydrological model - Soil and Water Assessment Tool (SWAT). The astronomical tidal height for different return periods was calculated by fitting a synthetic time series for tidal level into a generalized extreme value model. Following this, the MIKE 11 model was set up which simulates the flow of water along the river channel. The stormwater drainage network was coupled with the MIKE 21 model which simulates the overland flow due to the rainfall received over the study area to develop the flood model. The influence of

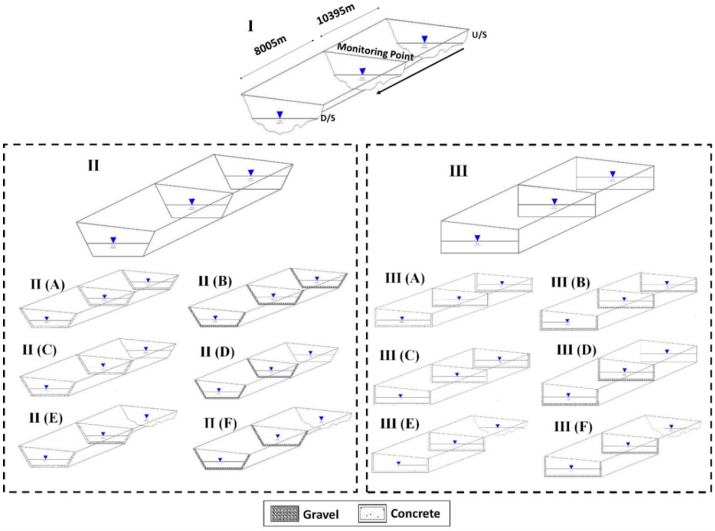
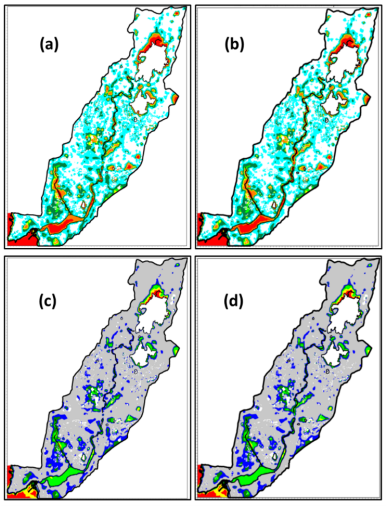


Figure 2: Representive figure of different hydraulic scenarios utilized in the study (Ghosh et al., 2021)



Description of Inundation	Number of cells under each index		
	Original C/S Scenario I	Scenario II (E)	Scenario III (E)
Very Severe (V, VI, VII)	94717	90159	91677
Moderately Severe (III, IV)	110916	109198	104943
Less Severe (I, II)	490777	497053	499790

Description of Hazard	Number of cells under each index		
	Original C/S Scenario I	Scenario II (E)	Scenario III (E)
Very Severe (V, VI)	37047	30538	31236
Moderately Severe (III, IV)	75785	77834	79868
Less Severe (I, II)	583578	588038	585306

Figure 3: Flood Inundation maps for (a) scenario II(E) and (b) scenario III(E), and Flood Hazard maps for (c) scenario II(E) and (d) scenario III(E) for a 200-yr return period extreme event (Ghosh et al., 2021)

a total number of 45 hydraulic scenarios, for rectangular and trapezoidal cross-sections with concrete and gravel lining materials represented in Figure-2, over flood inundation and hazard maps was evaluated for 10, 50 and 200 year return periods of rainfall, discharge, and tidal impact. Flood inundation maps consider the depth of the water during a flood event whereas the flood hazard maps consider both depth and velocity of the water.

It was observed through the proposed network that the scenario with a trapezoidal river cross-section and concrete lining material was found to cause the maximum decrease in flood inundation as compared to the other scenarios in the case of the Mithi River. This could be attributed to the fact that the water carrying capacity of a trapezoidal cross-section is greater than the others which results in higher storage of water in the river channel and lesser spilling of river water across the banks. Furthermore, the high density of the population adjoining the river and current situation of river limited the usage of other available options in case of the Mithi River. In urban regions, in the flood-prone regions, where there is presence of a large population and the population density is high, implementation of structural measures for flood management is often hindered due to lack of sufficient space. A generic user-friendly framework which is an integration of structural and non-structural measures could be used as a potential flood mitigation option. The developing and under-developed countries can benefit from this framework, where the inadequacy of sufficient data hinders the application of such strategies.

Conclusions and Recommendations

With climate change increasingly showing its impact on different aspects of the environment, it is high time for the people to come together to make themselves more resilient and prepared towards unprecedented extremes. The rapid increase in extreme events and damages resulting from them over the last couple of decades highlights the inadequacies in the current flood management system as well as the necessity to further improve and amplify the measures being taken to make the country flood resilient as much as possible. At the same time, steps must be taken to make the earth environmentally sustainable by striking a balance between human needs and desires so that climate change can be reversed as much as possible before these rapidly increasing extreme events cause unmanageable damage. The following measures are recommended to strengthen and improvise the current flood management system:

- The existing flood management strategies focus primarily on structural measures like building dams, embankments while giving comparatively less importance to non-structural measures floodproofing, flood zoning, warning systems, etc. The scientific community along with administrative bodies and stakeholders have to work towards the integration of structural and non-structural measures, scientific and technological knowledge development, and strategizing flood prevention and protection measures.

- The administrative authorities need to be more proactive in enforcement of flood protection and prevention measures, sanction projects for flood control and regularly inspect their progress, and imposing penalties in case of failure of completion of these projects, as contracted. The future climate change scenarios should also be considered while taking any administrative decision regarding structural and non-structural flood control measures. A committee should also be formed for regular evaluation of the performance of completed flood control structures and the existing non-structural measures and improving them if required.

• The condition of residential and commercial buildings and other structures in the flood-prone areas should be regularly assessed for their resilience to heavy flooding events.
• A balanced approach with appropriate combination of structural and non-structural flood management strategies should be adopted. Such a combined approach would no doubt vary across cities due to their physical and socio-economic conditions, and hence all major cities in India should initiate studies to identify and prioritize flood management strategies.

• Inventorization of all information related to flood like hydrometeorological data, inundation maps, return period of past catastrophic flood events, and data required for flood mapping and zoning should be made freely accessible to researchers and the scientific community in a single platform to enable them to come up with better management tools and ideas. Websites and mobile-based applications can be utilized to sensitize the general public to relevant information about any flooding events without causing any panic or fear amongst them.

• The spatial information related to flood management such as land use and land cover data, flood hazard maps, rainfall and streamflow data at different monitoring stations, forecasts, etc., should be Geographic Information System (GIS) compatible. The professionals working in various government bodies, non-governmental organizations, and local administrative authorities related to flood management should be thoroughly trained to work on GIS platforms so as to equip them for quick and informed decision making and dissemination of valuable information pre and post any heavy rainfall event.

• Awareness and education programs for the general public should be organized to make the overall system flood resilient and self-dependent in case of any flood-related emergencies by adapting approaches for protection, control, preparedness, and mitigation.

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NEWS

Mindless 'development' could bring more calamities like Chamoli and Kedarnath floods

The Indian EXPRESS
Saturday, August 28, 2021

People do not want to risk their homes, fields, pastures, forests and rivers in the name of development. Most of such development work in the Himalayas is being carried out without an understanding of its fragility, seismicity, glacial behaviour, climatic changes and their collective destructive power.

As a mountain system, the Himalayas have had earthquakes, avalanches, landslides, soil erosion, forest fires and floods, and these are its natural expressions, parts of its being. (Illustration: C R Sasikumar)

Urban Flood Modelling: Concern to Solution

Dr. Rajesh Gupta
Professor, Civil Engineering Department
Visvesvaraya National Institute of Technology

Ritesh Vijay
Senior Principal Scientist & Head
Wastewater Technology Division,
CSIR-National Environmental Engineering
Research Institute (NEERI), Nagpur

Siddhant Dash
Research Scholar
Department of Civil Engineering
Indian Institute of Technology Guwahati

Introduction

Most of the cities in the world are undergoing urbanization, leading to the rapid change in the land use scenario which subsequently has a remarkable impact on the runoff generation and thereby leading to urban flooding (Vijay et al., 2007; Wilby et al., 2008, Woodruff et al., 2013, Zheng et al., 2014). There is a serious need of analysing the impact of land cover change for the formation of land use policies and management of consequential floods. The scenario is very difficult in the cities where the urban settlements are besides a river or natural drain. Sustainable flood management has turned out to be a severe challenge for the decision makers and urban planners, especially in the densely populated urbanized areas (Shah et al., 2018). The imbalance amongst the floodplains of water bodies and the land-cover practices has enhanced the chances of occurrence of the floods in urban areas (Joshi et al., 2011). All that even though the catchment characteristics are being adopted more precisely and use is being made of modelling tools with data from remote sensing satellite, Geographical Information System (GIS), Global Positioning System (GPS) and drone survey, which are becoming more accessible (Sargaonkar et al., 2006). Earlier, most of the factors were not being considered for urban flood modelling because of the low-resolution images and inadequate data sources as well as lack of basic working principle and understanding of the state of the art.

Flooding in urban areas is caused by the flash floods, coastal floods and river floods. In fact, it is also occurring because of lack of proper drainage, unplanned development and sprawling encroachment near rivers, streams, seas and banks of water bodies. The adverse effects of floods often entail far-reaching socio-economic and environmental implications, and may include loss of life and property; mass migration of people and animals; environmental degradation; and shortages of food, energy, water and other basic needs (Vijay et al., 2009).

Case of Nagpur

A study of urban flood mapping and prediction has been carried out for Pili River of Nagpur, Maharashtra (Figure-1) and presented herein. The study was carried out in four stages, i.e., data collection, watershed delineation, model conceptualization, formulation and simulation. Rainfall data were required as input for the hydrodynamic simulations. The watershed delineation was carried out using Arc-GIS platform. The model was conceptualized in HEC-RAS (5.0.1) by using the data obtained from the processes mentioned below as an input.

The river length and its cross sections were used as an input in geometric data. The base flow of the river and peak flood flows of corresponding sub-watersheds pertaining to different return periods were given as an input for steady flow data. For the modification of the riverbed, the river bed was dredged for 0.5 m depth from invert level in order to reduce the flooding effect. The hydrographs were generated as per the procedures adopted from the Report of Central Water Commission for Lower Godavari Zone and they have been used as input for the model for 1D as well as 2D unsteady state simulation.

Simulations for Urban Flooding have been done for both Steady State and Unsteady State conditions. Gumbel's Extreme Value (Type I) distribution was used to estimate the rainfall intensities for different return periods and durations, which were formulated using IDF curves using empirical equations and theories of probability (Palaka et al., 2016). Generalized IDF formula using evaluated precipitation depth, and based on return period was used for formulating the intensities. The maximum daily rainfall data was evaluated from the available rainfall data. The rainfall Intensity-Duration-Frequency (IDF) relationship is one of the most commonly used tools for various engineering projects to study flooding (Singh and Zhang, 2007). For Unsteady State simulation, the procedures followed in the Flood Estimation Report of Lower Godavari Sub Zone 3(f) have been adopted for the derivation of flood hydrographs from the synthetic Unit Hydrographs. Flow Hydrographs were derived for 50 and 100 years return period.

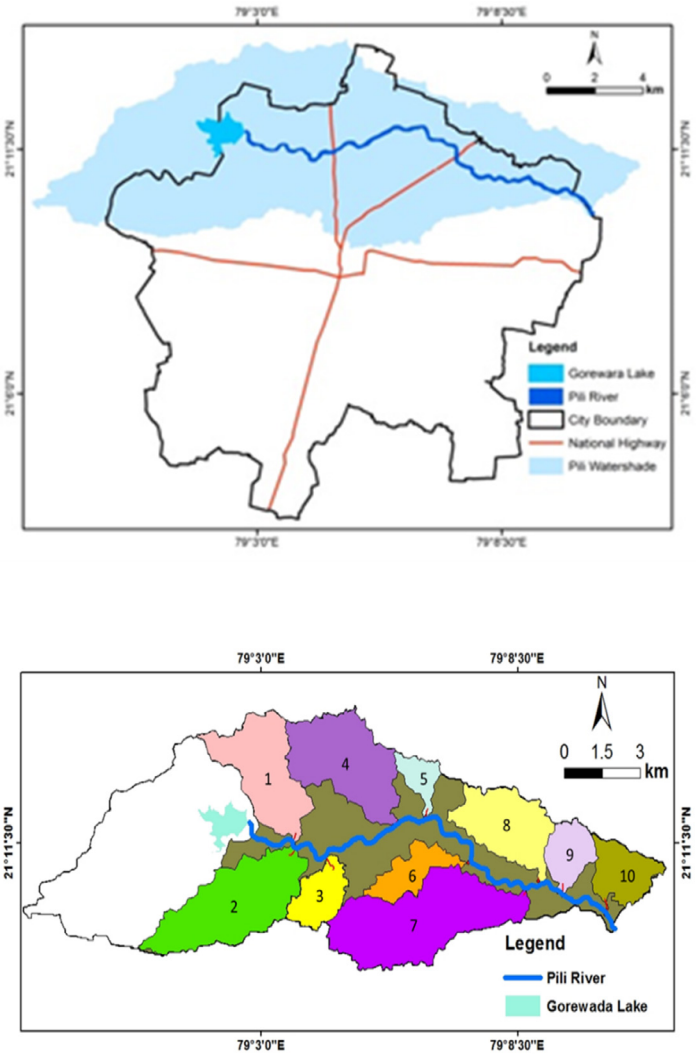


Figure-1: Pili River and adjoining drains in Nagpur

The outputs of the model are divided into four categories:

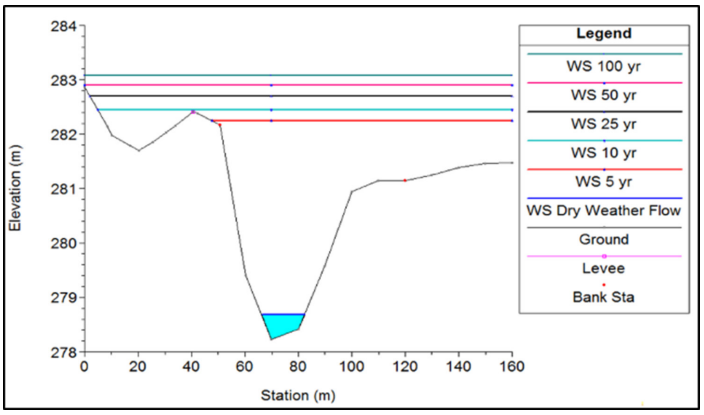
1D Steady State Flow

The Steady-State simulation for floods of different return periods include:

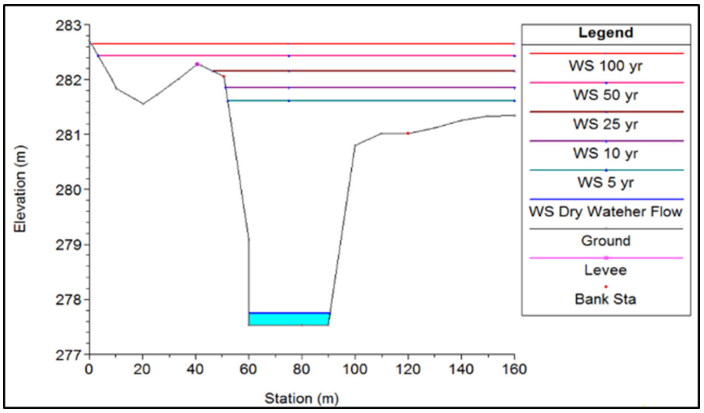
- Water Surface profile (Cross-sectional),
- Water Surface (Longitudinal) Profiles,
- Validation of the model, and
- Flood Lines.

The flood lines were delineated in Google Earth and Digital Elevation Model (DEM) to visualize the submergence during a flood of a particular return period based on the output of the water surface profiles for various cross-sections.

Water Surface Profiles The water surface elevations at various cross-sections are simulated for floods of different return periods. It can be seen that the water tends to overflow the river banks for the floods of 10, 25, 50, and 100 years return periods (Figure-2). Hence, the existing cross-sections of the river are not sufficient to accommodate the floods of even 10 years return period and need immediate attention towards riverbed planning and development. The water surface elevations for the particular cross-section after the river bed has been developed using dredging as an option for increasing the river channels' capacity. It can be seen that the water surface elevations tend to come down significantly to accommodate floods up to 25 years, thereby reducing the chances of flooding to a great extent.



(a) Existing River Geometry with Levees



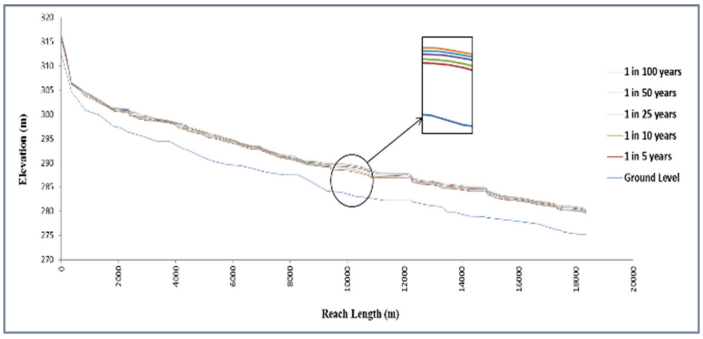
(b) Modified River Geometry with Levees

Figure-2: Water Surface Profiles for floods of different return periods at a River Station

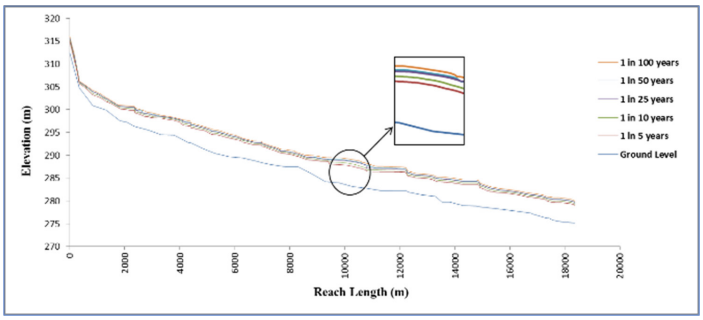
Validation was done of the results obtained from the model vis-à-vis the actual water depths measured on-site. Fourteen sampling points along the entire river stretch were selected for the validation of the results with the modeled output values. The results indicate that the water surface profile for the average dry weather flow obtained from the model correlated with the actual on-site data with a correlation coefficient of 0.8. Hence, the predicted water levels for the floods of different return periods from the model may be assumed to be valid to an acceptable magnitude.

Longitudinal Profiles

The longitudinal profiles were obtained after the simulation for base flow (dry weather flow) and once in 5, 10, 25, 50, and 100 years return period flows for existing cross-sections of the river (Figure-3).



(a) Existing River Geometry

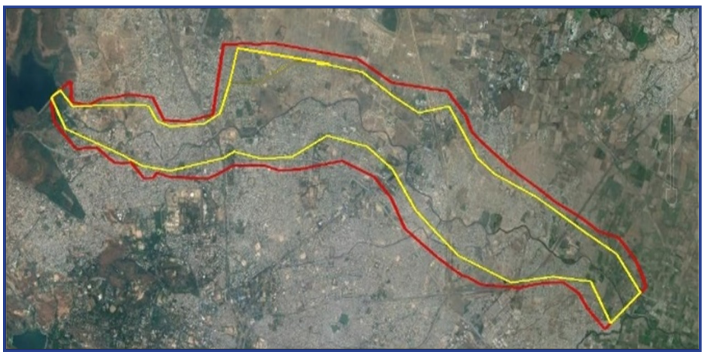


(b) Modified River Geometry

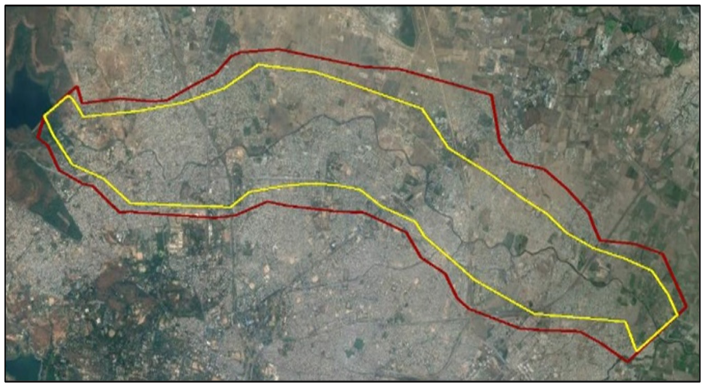
Figure-3: Longitudinal Profiles of the river

Flood Lines

The simulation results of the water surface profile for once in 50, and 100 years were used to delineate the flood lines along the river using flood points. The flood points are those that match the ground elevation with the flood water surface elevation of that particular storm. The flood points were marked on the Google Earth based on the results obtained from the simulation before and after dredging of the sections. The flood points were joined along the length of the study area for the 50 and 100 years return period storms for existing and modified river geometry (Figure-4). A significant difference in the flood lines can be seen at some points along the stretch of the river due to modification in the river bed geometry.



(a) Once in 50 Years



(b) Once in 100 Years

Figure-4: Delineation of flood lines under existing and modified river geometry on Google Earth for floods of different return periods (Yellow line indicates for the modified river geometry and the red line for the existing river geometry)

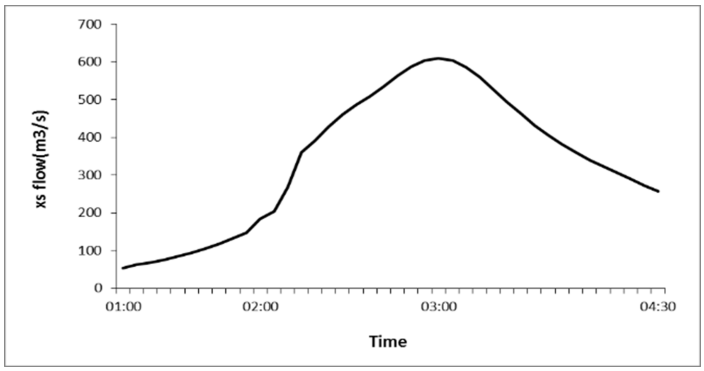
1-D Unsteady State flow

The outputs for the Unsteady-State simulation provided

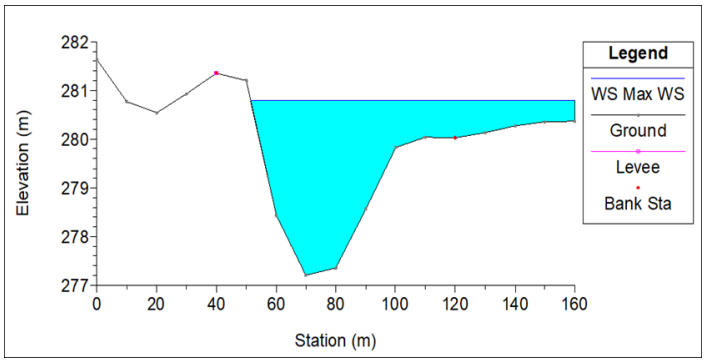
- Water Surface Profiles (Cross-Sectional), and
- Unsteady Flow Time Series Plot

Water Surface Profiles

The variation of the water surface elevation has been represented in Figure-5, which shows a time-series variation of the water surface elevations for the RS 980. Flow Hydrograph and maximum water surface elevation for once in 50 years and 100 years are depicted in Figure-5a and Figure-5b respectively.

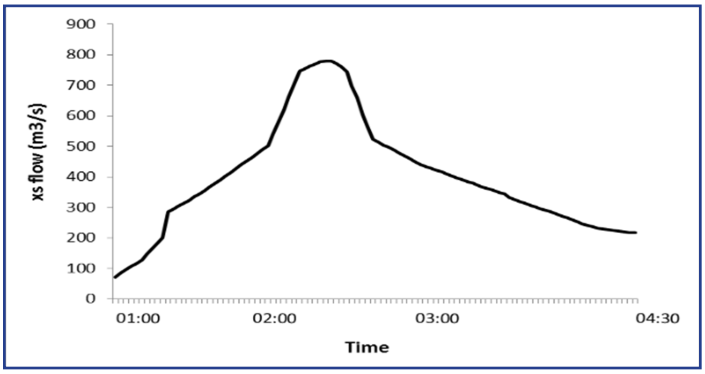


(i) Flow Variation (Flow Hydrograph)

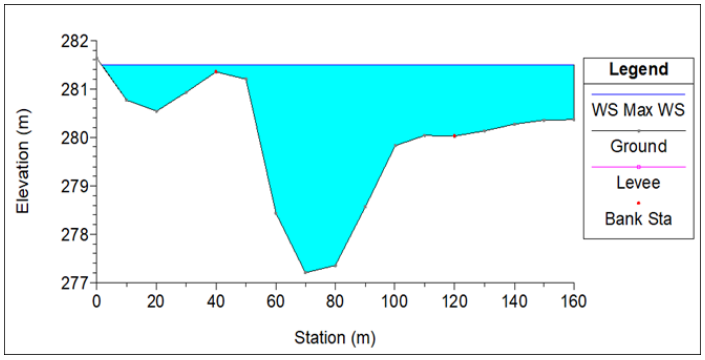


(ii) Maximum Water Surface Elevation

(a) Once in 50 years



(i) Flow Variation (Flow Hydrograph)



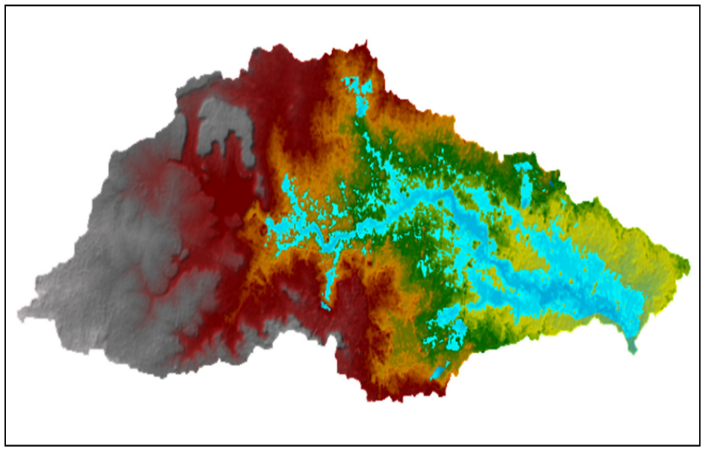
(ii) Maximum Water Surface Elevation

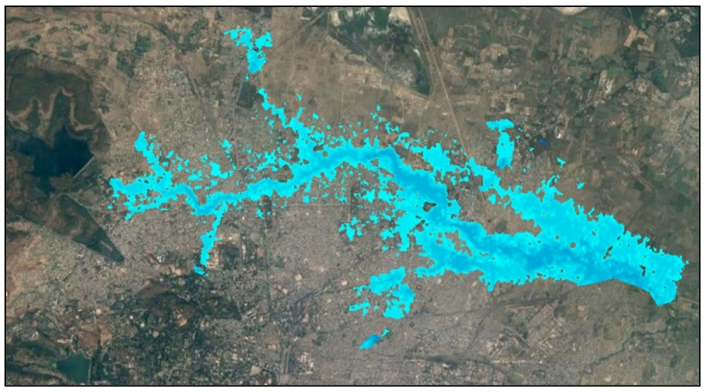
(b) Once in 100 years

Figure- 5: Maximum Water Surface Elevation for RS 980 under flood hydrograph

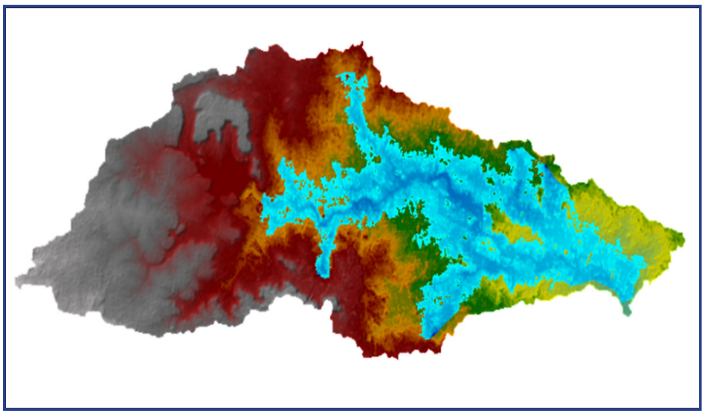
2-D Unsteady State flow

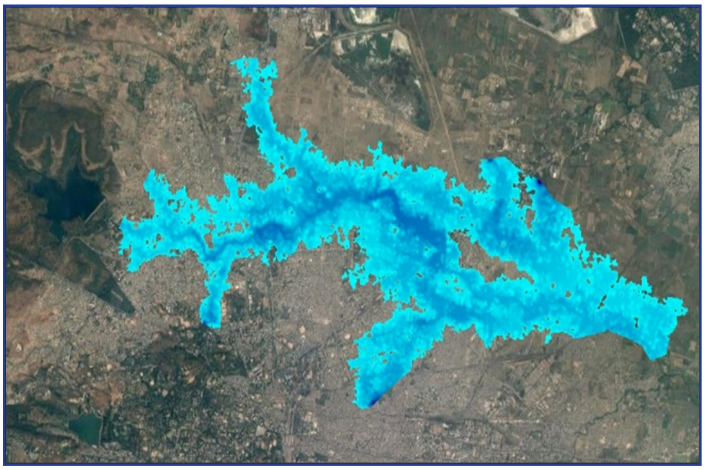
The 2D Unsteady-State simulation provided a two-dimensional flood inundation map. The area of submergence with once in 50 years and 100 years return flood on DEM and Google Earth are shown in Figure-6a and Figure-6b respectively.





(a) Peak for 50 years return period





(b) Peak for 100 years return period

Figure- 6: Representation of flood inundation maps on DEM and Google Earth

Conclusions

To handle the problem of urban flood, there is a need for effective flood modelling, mapping and management with the objective of conceptualizing model and generate various scenarios and then decide on the mitigation measures. Identifying flood prone areas depending on modelling scenarios helps in arriving at the short-term and long-term mitigation measures. That will enable a Flood Action Plan to be prepared including the City Master Drainage Plan incorporating effective flood management and mitigation policies.

Acknowledgements

Authors are thankful to Director, VNIT, Nagpur and Director, CSIR-NEERI, Nagpur for providing infrastructure support to carry out this research study.

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NEWS

Hindustan Times
Tuesday, Oct 12, 2021 New Delhi 35°C

Rain, floods killed 6,800 people in India in last 3 yrs; Bengal tops list

West Bengal topped the list of states with at least 964 such deaths, revealing the state's vulnerability to climate change. This means one in every seven such deaths were reported from the state between April 2018 and March 21, according to data placed in the Lok Sabha in August this year

By Joydeep Thakur

India has lost 6,811 people in the last three years to hydro-meteorological disasters such as heavy rain, lightning, flood and cyclones till March this year, according to government information to Parliament.

Source: https://www.hindustantimes.com/india-news/rain-floods-killed-6-800-people-in-india-in- last-3-yrs-bengal-tops-list-101631589513739.html

Good Practices for Flood Management in Built Environment

G N Virupaksha
Group Sector Head-Water

Sanjay L Lalan
General Manager-Environment

Pavan Kumar N
Senior Manager-Civil
TATA Consulting Engineers Ltd.

INTRODUCTION

Over the years, cities have grown on account of new areas being merged and urbanization usurping available open. All that has changed the natural drainage system substantially, thus often resulting in flooding and water logging which cause considerable inconvenience and economic losses. Rapid and unplanned urbanization and their inadequate maintenance results in drains being silted. Once the drains are broken/ damaged smooth connectivity for flow of the storm water is lost and water logging arises. Most urban areas have open drains and hence solid waste is dumped into them which further reduces their carrying capacity. Operation and maintenance of the drainage systems are not adequately planned and executed; very often neglected. Besides ULBs do not have machineries and equipment for cleaning the storm water drains. Thus, water bodies are polluted due to the discharge of untreated sewage, dumping of solid waste and encroachments. There is need for planning and executing integrated drainage systems in the urban cities in consonance with all the other services. A comprehensive Master Plan of all services and then a more detailed Master Plan for Storm Water Drainage system needs to be prepared. Thereafter the works must be prioritized and executed as planned.

Storm Water Drainage Systems: For urban areas the storm water drainage systems can be categorized into:

1. Natural Drainage Systems i.e., rivers, streams and water bodies
2. Manmade Drainage Systems i.e., storm water drains and channels

Drainage Zones and Planning of Drainage: To plan the storm water drainage system the prime requirements are topographical & contour survey maps to determine contributory areas for the different reaches of the drains. These should be demarcated based on which more detailed survey should be carried out for the areas under consideration. The demarcation of zones should be verified physically at site and the details and the conditions of the existing drains marked and recorded. The city drainage area should be divided into major storm water drainage zones based on the different area runoffs contributing to the major water bodies, streams, rivers, nallahs, etc.

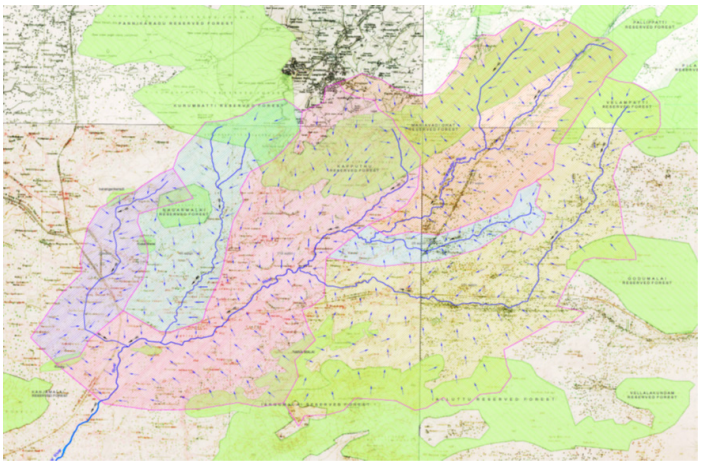

Figure-1:
Catchment Area Demarcations of Primary Drains/Water Bodies

An adequate and integrated storm water drainage system is a prime requirement to prevent flooding since that is the means of conveying the storm runoff into drains, as per the natural topography, to predetermined locations. The river/ primary drains passing through an urban area may not be perennial ones; they could be seasonal and function only during the monsoon season. However, during the monsoon seasons, ULBs generally face the problem of most areas in the city being affected by floods. It is the low-lying areas and those along the banks of the existing water bodies, rivers, drains which suffer due to encroachments. A feasibility study should inter alia enable analysis of the efficacy of the primary

drains existing in the urban area. Modifications and new works should be based on detailed Master Planning cum Feasibility Study. These typically comprise:

1. Integrating the planning of all services for the urban area in toto, keeping all future requirements in mind for a horizon of 50 years

2. Drainage improvement works for local area flooding,

3. Remodeling of primary drains,

4. Improvement works such as cleaning and de-silting of drains,

5. Lining and covering of drains, and

6. Grated entry into of storm water into the drains.

As a part of the planning, design and project formulation process, the basic design parameters are to be determined for detailed design to analyze the carrying capacity of existing primary drains and also for the new drains wherever required so that the planning is holistic.

Computation of Design Flow: Runoff to be computed for each drainage zone and sub catchment areas. The parameters and factors for the computation should be carefully studied and decided.

Frequency of Storm: As per the recommendations in CPHEEO manual, a return period of once in 2 years to be adopted for estimating the runoff for tertiary drains whereas for secondary and primary drains a return period of once in 5 years could be considered. However, based on the large-scale flooding and the changes in the climate, it is recommended that in very large urban area such as metropolitan areas, a return period of once in 100 years is suggested. The capital outlay would no doubt be higher but would prevent the loss of lives as well as economic and financial losses which could be much higher.

Rainfall Analysis and Intensity - Duration - Frequency (IDF): Rainfall analysis to be carried out from the available rainfall data from IMD for last 2 to 3 decades using various methods such as Gumbel Distribution Method, Annual Exceedance Method, IMD 1/3rd Rule, Bells formula for computation of intensity, duration and frequency of storms. The Intensity Duration Frequency curves should be developed by selecting appropriate method for a city based on topography, rainfall pattern, climate change, prevailing site conditions and also be compared with IMD Iso-pluvial maps. A typical Intensity Duration Frequency Curves are shown in Figure 2.

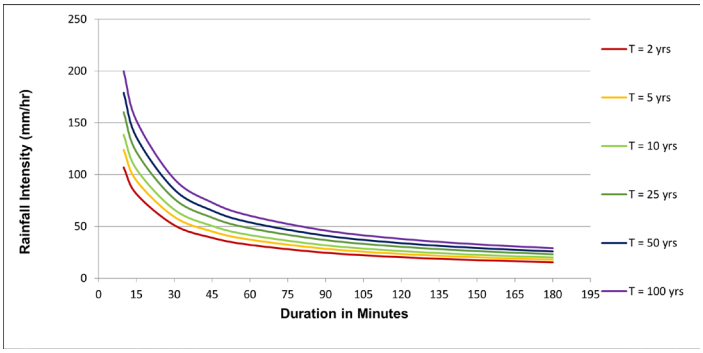

Figure-2: Intensity Duration Frequency Curves

Coefficient of Runoff: The co-efficient of runoff should be calculated based on the time of concentration and wetted average imperviousness of the respective catchment area based on the Horner's table in the CPHEEO Manual.

Coefficient of Roughness: The values of co-efficient of roughness should be adopted as recommended in the CPHEEO Manual.

Material for Drains: In medium and small urban area, the primary drainage system could comprise of trapezoidal drains made of stone masonry and/ or RCC rectangular drains. The secondary drainage system could be RCC drains with or without perforated cover slabs, brick/ stone masonry drains in densely populated and high traffic areas and open drains of RCC in undeveloped areas. For wide drains, RCC drains with RCC cover slabs can be considered. Roadside drains can be brick masonry, stone masonry and RCC drains depending upon the practices and easily availability of materials. For large urban areas, covered rectangular drains in brick or stone masonry or RCC or piped drains are most appropriate. All drains must have grated gutters for water entries to prevent solid waste and especially plastic entering into the drains.

Minimum & Maximum Velocities: Drains are to be designed to achieve a minimum self-cleaning velocity of 0.6 m/sec at the design flow and a limiting maximum velocity of about 3 m/sec for RCC drains. However, in primary drains, a maximum velocity of 6 m/sec can be allowed.
Minimum Freeboard: Clause 4.9.3 of IRC -SP 50(b) to be followed for freeboard for drain which varies from 100 mm to 300mm based on the bottom width of drain.

Drain Section: As per IRC SP - 50, it is recommended that the minimum width of a drain should not be less than 250 mm. In case of pipes the minimum diameter should not be less than 450 mm. In case of road width less than 3m wide, precast kerbs and grated gutter need to be provided as per site condition.

Hydraulic Design: Hydraulic designs to be carried out using Manning's formula and hydraulic modeling using StormCAD software and also for optimisation.

Analysis of Primary Drains:

At times it has been observed that even though the primary drains receive flow only during the monsoon, they run full or even overflow during recent years. That could be due to the change in the land use, change in the rainfall pattern and reduction in the carrying capacity of drains due to dumping of solid wastes, vegetation growths, silting of the beds and encroachments of the banks of major drains/ streams. For analysis and adequacy check of the primary drains, three scenarios are to be studied – Natural earth with vegetation - dense turf with sprouts; Natural earth with vegetation - average turf with no sprouts - Modified cross section; and Paved concrete Drain. Primary drain analysis to be carried out for the three different scenarios using software such as StormCAD for modelling. The modelling helps in deciding the sections which need to be lined, need improvement and remodeling.

Analysis and Remodeling of Primary Drains:

The basic scenario for which, the drain is to be analyzed is the existing condition and cross section i.e., drain containing solid waste, vegetations and deposit of silts, etc. The section of the primary drain as existing would

be insufficient to carry the design flow. The analysis of the drains also has to be done for the modified cross sections without altering the bed levels and width and considering that the drain would be de-silted and cleared of all vegetations and solid wastes. In that case, some sections may fulfill the design flow capacity requirement. The third scenario analyses the drain for the same condition as of Scenario - 2 but considering that the sides and bottom of the drain were lined. For the modified section the carrying capacity of the drain should be adequate for the design flow.

Analysis of Secondary and Tertiary Drains:

The sub-catchment areas should be marked in each zone based on the ground profile and the quantity of storm water generated in the various sub-catchment areas and zones and then the same should be demarcated in StormCAD software. The runoff generated in the sub-catchment areas is to be collected in the proposed drains. The length of the sub-catchment to be taken from the farthest point of the sub catchment area upto the collection point for calculating the time of concentration. The highest and lowest ground levels in each sub-catchment are considered to determine the slope of the catchment area.

Flood Control Measures

1. Right of Way for primary drains and River should be kept free from encroachments and habitations.

2. Wherever required, improve the hydraulic carrying capacity of the roadside drains. The drains to be either remodeled or replaced with new drains (within available right of way).

3. Public awareness program to be conducted, and people trained and educated regarding maintaining of hygienic environment and ensure safe conveyance of storm water and of keeping the drains in good conditions for their own health and safety benefits.

4. Wherever the sections of primary and secondary drains are to be widened, a resettlement plan for the project affected people should be drawn up.

5. The downstream drain of the lakes should be logically connected to the mainstream for conveyance of runoff and its safe disposal.

6. The water bodies, etc. should be desilted and all vegetations and solid waste cleared. They should be fenced, and beautification work carried out wherever feasible.

7. Conservation programs for the water bodies should be taken up.

8. Damaged portions of the roadside drains should be rectified.

9. Wherever major open drains pass near a road, they should have signage to warn and prevent pedestrians and vehicles from falling into the drain.

10. Before every monsoon season, the roadside drains should be desilted, cleaned and repaired.

11. The primary drains sections should be improved wherever required. Encroachments along the streams / primary drains should be removed.

12. The sewage outfall to the water bodies should be intercepted and diverted to an STP for treatment.

13. Sewage entry into stormwater drains should be prevented by implementing a sewerage system and 100% house sewer connections.

14. Drains should be remodeled wherever required to carry the peak storm flows without causing any flooding.

Priority of works: Depending upon the criticality and need, the proposed storm water drainage works should be classified into priorities as per the CPHEEO/ MoUD guidelines – thus the first priority is as being for a Smart City Proposal, second priority as Areas subject to flood inundation/ low lying areas and primary drains, third priority as integrated lake development with necessary interconnections, and fourth priority as other remaining drainage areas.

WORKS FOR THE DRAINAGE SYSTEM

Proper Sectioning of Primary Drains: Based on analysis of the existing cross sections of the primary drains, they should be modified with proper side slopes as per the design requirements along with proper provision of bunds on the banks of open drains. In case of closed drains also the same considerations will apply.

Providing Fencing along the Primary Drains: To restrict illegal encroachment and to avoid littering and dumping of solid waste into the stream, chain link fencing to be provided all along the length of primary open drains on the both the banks.

Provision of Flow Measurement Device along the Primary Drains: Based on the detailed inventory of drain and the information obtained from site, flow measuring devices to be provided on natural streams. The observations and monitoring would further help in assessing the proper section required to mitigate their flooding. To facilitate flow measurement a simple weir structure could be provided at the exit point of each stream before its confluences with the river or water bodies.

Rainwater Harvesting System for Primary Drains: Ground water recharge pits inside primary and secondary drain areas by the side of the storm water drains would help hold water. Suitable arrangement should be made so that the overflow from the drains flows into these recharge pits located at every 500m intervals along the stream. The general arrangement of a Rainwater Harvesting structure is shown in Figure-3.

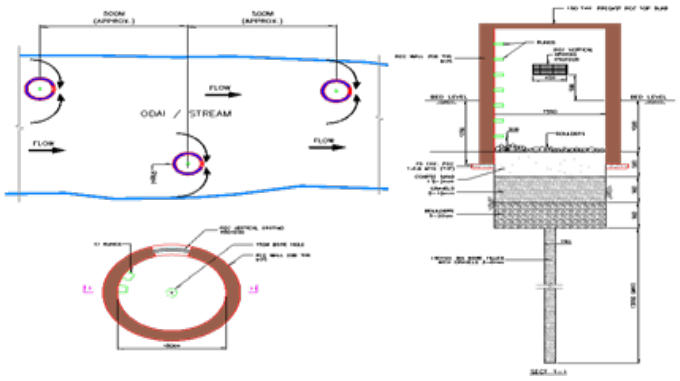

Figure-3: Rainwater Harvesting structure at 500m interval along the length of primary drains

Outfall of Lakes and its Connectivity: Where the outfall stretch from lakes are encroached and the natural path of conveying the runoff to the river/ stream or a subsequent water body has been disturbed, the existing path would need to be remodeled and a new drain from downstream of the lake made to connect to the river/ stream.

GIS Mapping of Storm Water Drains: GIS mapping of storm water drainage infrastructure enables capturing all the existing and proposed assets into a GIS platform which would also benefit planning for future investment, data base management, effective operation and maintenance services and improving service levels.

DISCUSSIONS AND CONCLUSIONS

It is important to study the existing storm water drainage system, identify the gaps and challenges and operation & maintenance issues faced by the body in-charge of the system. An integrated storm water drainage system based on the catchment area study by means of topographical and contour surveys is crucial. Analysis of existing drains to be carried out and improvements suggested to cater to the design runoff. Rainfall analysis and the selection of a mathematical model is very critical for the development of IDF curve and designing of drains which are to be decided based on the rainfall pattern, rainfall data and best method applicable for the area under study. Prioritizing of the works to be based on the criticality and severity of the need to address the flood problems and preventing loss of property and human life.

Asset Management which inter alia includes Operation and Maintenance is an important aspect for the proper and intended functioning of the assets that are created. Cleaning of drains by machines makes it easier and faster. Training and capacity building program also are necessary for training on storm water drainage network modeling using software, enhancing skills of the Operation & Maintenance personnel by classroom training and field visits to other cities where best practices have been implemented; studying the advanced storm water drains machineries for effective Operation & Maintenance, GIS mapping and Operation & Maintenance best practices. A 10 years Operation & Maintenance period of SWD system when incorporated in the bid document would ensure proper implementation of the project intent.

ACKNOWLEDGEMENT

The authors are grateful to TATA Consulting Engineers Limited for allowing this article to be submitted.

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NEWS

The Indian EXPRESS
Saturday, August 28, 2021

Despite Supreme Court freeze,7 Uttarakhand projects get ok, 1 flash-flood hit

Ever since the Supreme Court moratorium in August 2013, the Environment ministry has formed several experts panels and switched its position from accepting the first expert committee's report that blamed dams for exacerbating the 2013 disaster to backing the latest expert committee's conclusion that 26 hydel projects could go ahead with certain design modifications.

Written by Jay Mazoomdaar | New Delhi |

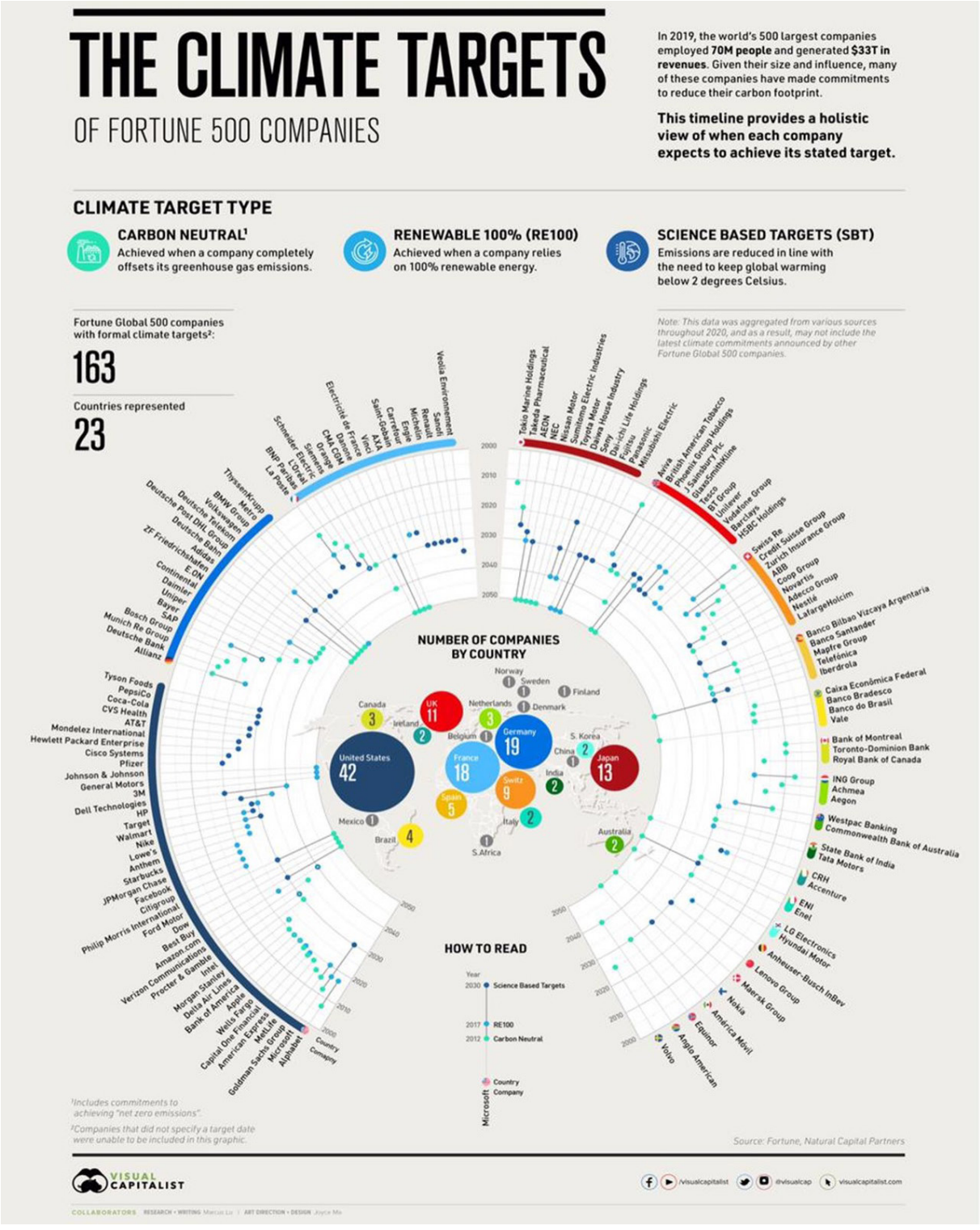
Updated: August 27, 2021 7:26:07 am

The Climate Targets of Fortune 500 Companies

As of October 2020, 163 companies from the Fortune Global 500 have publicly committed to achieving at least one of these climate targets. That represents 32.6% of the total group.

The most common target is carbon neutrality, which has 91 companies on board. In second place is science based targets (SBT), which has 74 companies committed - of those, 16 have not declared a target date. RE100 was the least common, with 56 companies committed. Because some companies are committed to multiple targets, these figures add to more than 163.

Only 2 Indian companies name Tata Motors and State Bank of India appear for the 2030 targets.



Green Infrastructure for Flood Management & Sustainable Urban Environment

Dr Ajay Pradhan
President & CEO

Vijay Kumar
Principal Hydrologist
Cetus Consulting Solution Services Pvt Ltd.
New Delhi

Introduction

Urban floods in areas with relatively high intensity rainfall requires ability to quickly dispose of water to prevent water logging in the urban areas. With climate change, planning for resilience for its impact has to be integrated in the planning and design of urban areas. Increased rainfall intensity and higher rainfall and consequent increased flooding is one of the projected impacts of climate change. Climate Change Adaptation and building resilience will improve the efficiency in flood risk management by building capacity, raising awareness, and improving response to disaster, and improving the drainage and storm water systems. Structural measures include large grey infrastructure (lakes and water bodies and storm water drainage) to increase drainage capacity towards the Nambul River. Very often the local drainage as well as the final disposal channel are encroached and constricted or hydraulically inefficient to quickly discharge the water. In such cases, one of the solutions can be to store the flood water in a holding pond or flood storage reservoir towards moderating flood and could also be used to augment the water supply, improve the urban ecology and environment and many other economic benefits in the surrounding areas. In this paper this approach to flood management has been presented with a case study on western Imphal. The approach is replicable for similar areas.

The Study Area

This study has been carried in the Lamphelpat (marshy wetland) area situated in Imphal West District. The area is important and currently constitutes the central part of Imphal West of Manipur, which geographically extends between latitudes 24°49' to 24°50' N and longitudes 93°54' to 93°55.5' E. The area is characterized by almost flat urban land and wetland. Several areas including those of National Institute of Technology, Manipur near the study area is vulnerable to water logging due to constricted drainage, silting, change of slopes and poor hydraulics of the drainage network. The flood of 2017 is the most recent that caused large scale disruptions and damage.

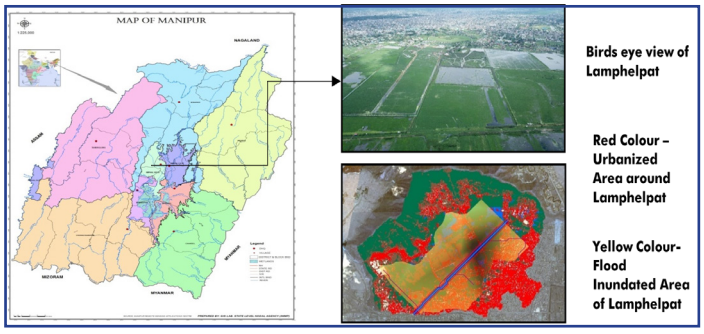


Figure-1: Location of Lamphelpat and its surroundings

Figure-1 shows the location map of the study area. Though entire area might have been a wetland in the past, the current situation shows large part of it have been developed. The Lamphelpat area was originally serving as a temporary flood detention reservoir for the Nambul River catchment. Presently, the Loktak lake is almost filled-up due to upland erosion from the upstream catchment. Beside this, the land has been reclaimed for various residential and non-residential buildings leading to further reduction in the detention capacity of the lake and thereby causing a flooding problem. According to the findings presented in the Manipur State's Action Plan on Climate Change (2013), the projected impact in Manipur region includes the following:

• Increased river flow, with potential damage to river bunds

• In a dry situation drying up of rivers, increased evaporation, runoff and decreased soil moisture recharge

• Water pollution, siltation and scarcity of fresh drinking water.

Considering the above projected impacts, it is important not only to plan for flood, but also for augmenting water security which is likely to be reduced as an impact of climate change. Storing flood water and using it during lean season would certainly enhance resilience against climate change.

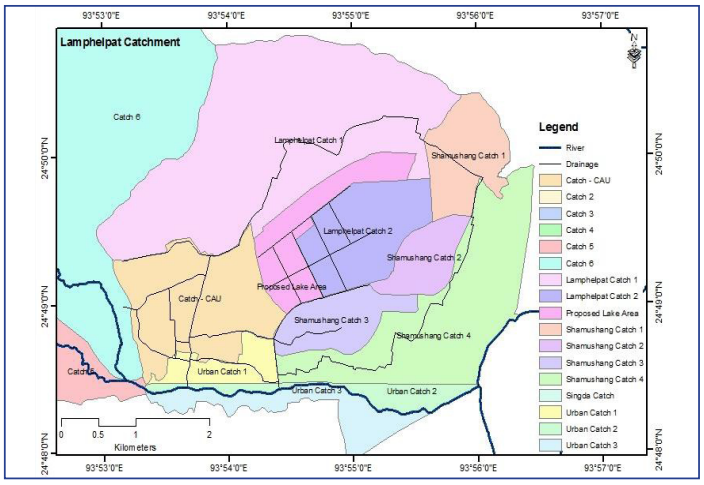


Figure-2: The Study Area

Figure-2 shows the study area. It is noted that a number of urban sub-catchments contribute to the proposed water body in the south-east. In addition, there are agricultural catchments and hilly catchments to its west. The Samushang Nala is an important natural storm water drain that drains the urban areas, Nambul River flows from West to East and serves as the major natural drainage of the study area. Sufficient carrying capacity of channels of Samushang nala and Nambul River would be important for proper drainage of the area besides the rejuvenated proposed water body in the wet land that would be used as storage to collect the storm water and minimise flood risk.

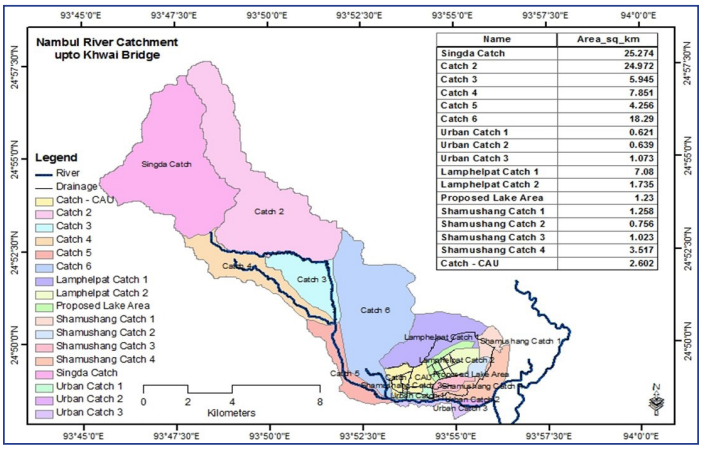


Figure 3: Catchment Area-Nambul River

The discharge from the above area drains into Nambul River. The area that is critical for the study starts from downstream of Singda Dam till the Khwai Bridge. The catchment area of Nambul River is delineated and shown in Figure-3. It extends between latitudes 24°47'28.6"N to 24°57'38.0"N and longitudes 93°45'26.4"E to 93°57'42.7"E. The catchment may be divided into three major categories: Hilly catchment (i.e., Singda catchment up to the Singda dam and Catch 2), Agriculture catchment (i.e., Catch 3 to 6), and Composite catchment of the Lamphelpat area. The composite catchment is characterized by urban, agriculture, wetland and hills. Table-1 presents the important drainage components of the study area, the issues involved, the possible solution and approach adopted to address them.

Table-1: Components of Study, Issues and Proposals

S. No	Important Component of Study Area	Issues	• Proposal
1.	Lamphelpat catchment	• Drains to Lamphelpat and Nambul River • Higher runoff potential due to urbanisation.	• Improved drainage • Watershed treatment
2.	Samushang Nala (Main natural storm water drain)	• Constricted cross-section. • Inefficient hydraulics	• Re-sectioning • Improved longitudinal profile • Regulation by gate • Discharge to improved Lamphelpat storage reservoir.
3.	Lamphelpat	• Poor degraded and encroached wet land. • Insufficient storage to moderate floods.	• Creating a storage to contain 100-year flood. • Use of flood water for conservation purpose.
4.	Nambul River	• Silting and constriction of X-section due to gravelly bed and vegetation.	• Improved longitudinal profile and conveyance capacity.

The discharge from the above area drains into Nambul River. The area that is critical for the study starts from downstream of Singda Dam till the Khwai Bridge. The catchment area of Nambul River is delineated and shown in Figure-3. It extends between latitudes 24°47'28.6"N to 24°57'38.0"N and longitudes 93°45'26.4"E to 93°57'42.7"E. The catchment may be divided into three major categories: Hilly catchment (i.e., Singda catchment up to the Singda dam and Catch 2), Agriculture catchment (i.e., Catch 3 to 6), and Composite catchment of the Lamphelpat area. The composite catchment is characterized by urban, agriculture, wetland and hills. Table-1 presents the important drainage components of the study area, the issues involved, the possible solution and approach adopted to address them.

Materials and Methods

Table 2 provides the details of the data that has been used in the study. A lot of this data is generic and replicable for solution to similar problems.

Table 2: Lamphelpat Studies-Data Collected

Data/Information	Sources
River Basin Data and Information • Satellite Imageries, Maps and Topographic maps • Contour maps • Cross-section data for natural drains and rivers. • Sub-catchment Land Use • Hydro-meteorological Observation Network • Hydrometeorological data • Institutional setup - present and planned - with a horizon of 20 years • Master Plans, Reports, Data Volumes • River Environment Data • Aquatic Life • Low Flow Data	• Freely downloadable data/maps • NRSA • Survey of India • Topographic surveys of the area • State Irrigation and Water Resources Departments • International agencies selling Satellite Imageries and Maps • Reports and Appraisal Documents etc o International funding agencies
Master Plans and projections of population settlements including the illegal settlers and slums for all towns in catchments • Geographic and Demographic information • Natural Conditions	• Census 2001 and 2011 data • Town and Country Plans of the co-basin states • Published Information by each State • Available Reports on Water Audit Studies for Typical Industries • Primary Data and Information collected through Water Audit of Typical industries
Agricultural Practices and Water Use • Secondary information on soil surveys and soil chemistry • Types of Fertilisers Used and their dosages • Return flows • Collection of representative primary data	• States Departments of Agriculture • State Water Resources Departments • Fertiliser Factories • Primary surveys
Institutional Data and Information • Law, regulation, policy and practices • Organisational and institutional details • Financial Information	• State Government secretariats/ Departments • State Irrigation/ Water Resources and Public Health Departments • Published material • Web sites
Earlier Studies	• State Government Departments • State Remote Sensing Agency • State and Central Pollution Control Board

Approach to Analysis

The approach adopted for the analysis is explained in Figure-4.

As explained in above, there are three components of the study that are addressed in this study, viz. Lamphelpat catchment including the Samushang Nala, Singda Dam and Nambul River and Lamphelpat Water Body.

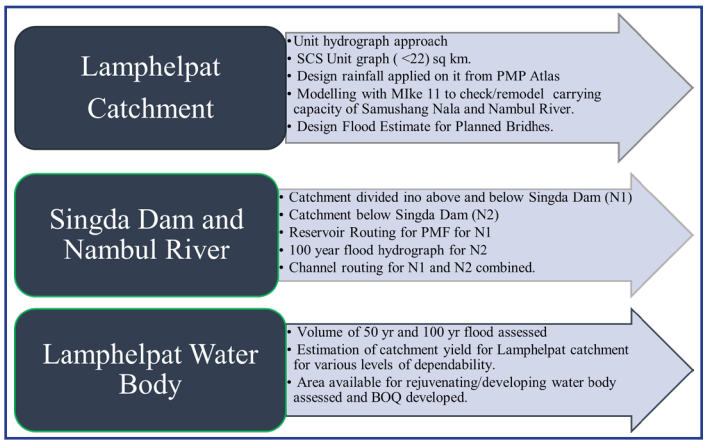


Figure-4: Approach to Analysis

For catchments greater than 25 km2, CWC has published Flood Estimation Report for Sub-zone 2(b) based on Unit Hydrograph approach (revised March 2000) and can be directly adopted for this area. Additionally, CWC has also published a PMP-Atlas for Brahmaputra Basin (2015) for estimation of design rainfall. Combination of the two can be used for estimation of the Design Flood hydrograph.

For catchments with catchment area less than 25 km2, it was considered appropriate to use SCS approach recommended in widely adopted HEC-HMS approach. This is particularly true for the Lamphelpat catchment with a catchment area of 22 km2 which is quite steep and the time of concentration for that works out to 1.75 hours. The estimated lag time was computed as 0.6 times of the Time of Concentration tc. The Time of Concentration (tc) for the stream catchment was also estimated as 1.75 hours using Kirpich formulas. The estimated lag time was 1.05 hour (63 minutes).

For catchment areas that are greater than 25 km2, 1 cm synthetic Unit Hydrograph of 1 hour duration was developed using the Flood Estimation Report for Sub-zone 2(b) and the Unit Hydrograph obtained. The following generic process was followed to get the design flood based upon Unit Hydrograph approach:

1. Synthetic Unit Hydrograph was obtained either from SCS approach for catchments less than 25 km2 or by application of the process provided in the Flood Estimation Report of Sub-zone 2(b).

2. The 24hr rainfall depth for T- year return period areal rainfall was obtained from PMP Atlas. This was converted into areal rainfall and distributed to obtain hourly rainfall using the data of Imphal and Tulihal.

3. From the hourly rainfall obtained in '2' above, applicable loss rate as recommended in Sub-zonal report for Sub-zone 2(b) was subtracted to obtain the rainfall excess at hourly intervals.

4. To consider the worst scenario, flood computations were carried out considering the bells of 12 hr each and applying the concepts of critical sequencing process.

5. The hourly rainfall excess obtained in 3 above was applied to hourly Unit Hydrograph ordinates and convoluted with a lag of one hour:

$$Q_n = \sum_{m=1}^{n \le M} P_m * U_{n-m+1}$$

Where:

n =1,2…. N: Time intervals for excess rainfall
m=1,2….M are the time intervals for direct runoff
Pm is the excess rainfall during mth time interval
Qn is the streamflow at end of nth time interval $\boldsymbol{m} = 1,2, ..., \boldsymbol{M}$
To the Direct Runoff ordinates at an interval of one hour, the base flow obtained from the report of Sub-zone 2(b) was added to obtain the Flood Hydrograph.

The above analysis was followed by Hydro-dynamic modelling using Mike 11 modelling. The components of modelling are illustrated in Figure-5. The illustration shows interconnection with the sub-catchments of natural drainage Samushang, detention reservoir and Nambul River. The modelling process is illustrated in Figure-6.

As explained in the aforesaid schematics, the design rainfall was determined using the PMP Atlas/ Sub-zone report. Synthetic Unit Hydrograph analysis was used to determine the floods of various return periods for catchments up to Singda Dam, Nambul catchment and effective area of Lamphelpat catchment for the proposed location of the reservoir. For Samushang catchment that is partly urban and partly agricultural in nature and smaller in area, the Time Area method was used together with Kinematic Wave Modelling. Channel routing was carried out using the Dynamic Wave modelling in MIKE 11 model.

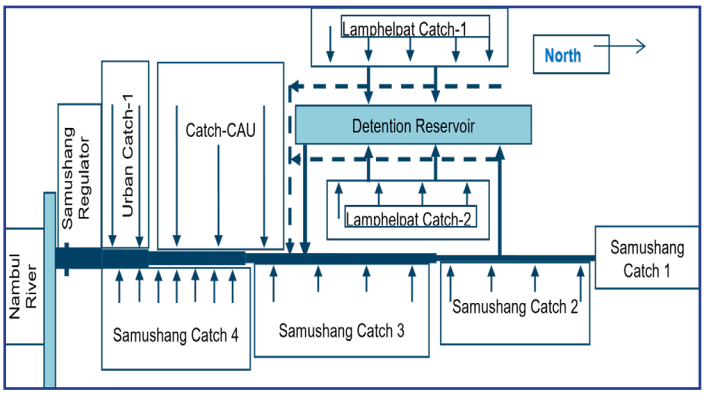


Figure-5: Components of Modelling

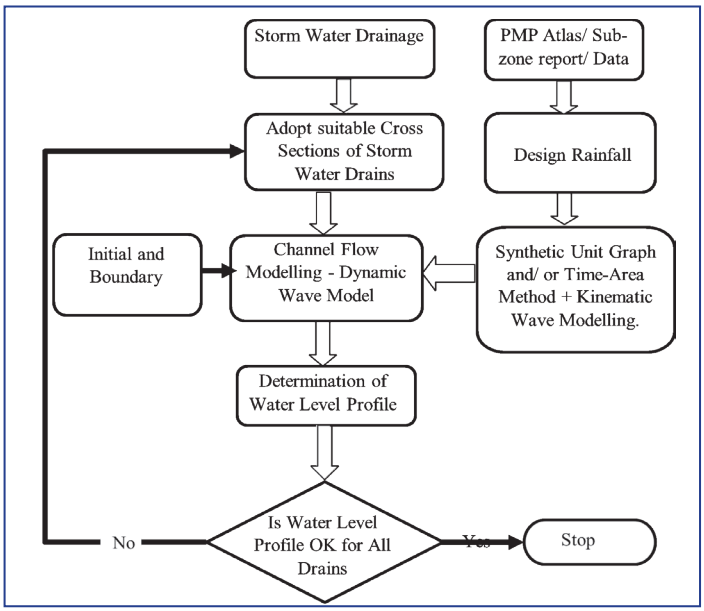


Figure-6: Process of Modelling

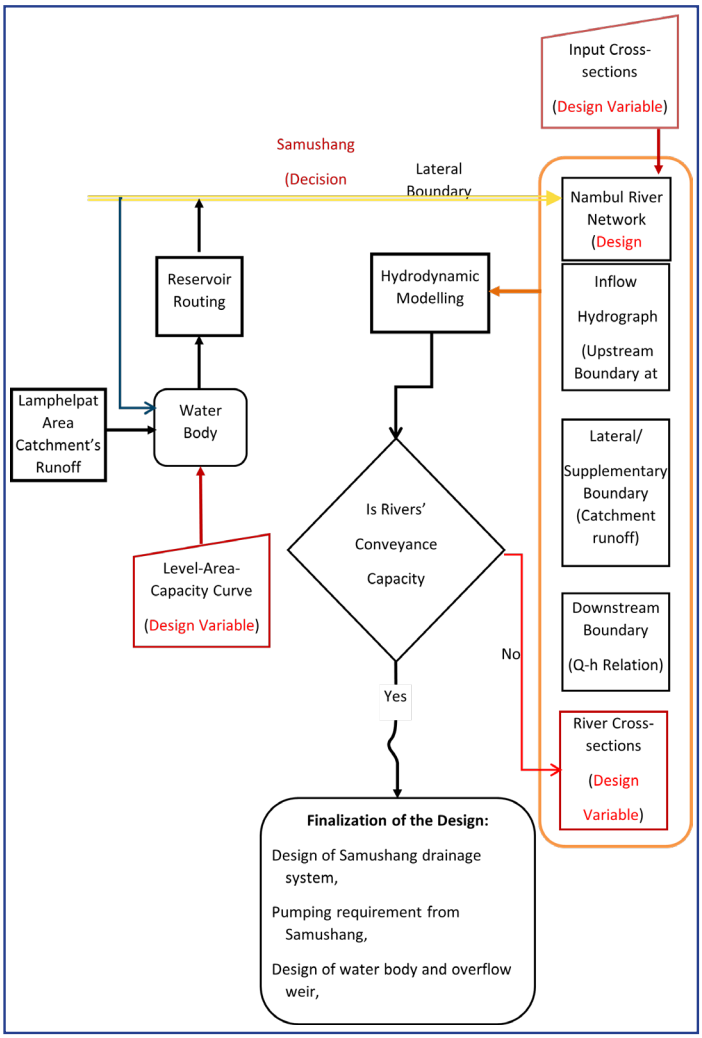


Figure-7: Simulation and sizing of various components by Modelling

Figure-7 illustrates the process that was used to decide various components for flood control viz. remodelled X-sections sizes of Samushang drain and Nambul River and sizing of the storage, apart from containing the 100-yr. flood another criterion for decision on the capacity of water body.

Results and Discussion

Singda Dam Nambul River

As a Design condition, it was considered that the Probable Maximum Flood impinges on Singda Reservoir when it is at FRL and outflow hydrograph was worked out by carrying out reservoir routing by modified Puls method. Two scenarios of channel routing were considered. a) Channel routing of 100-yr flood peak discharge through Nambul River without considering routed PMF from Singda Dam, and b) Channel routing for routed PMF and 100-yr. flood with their peaks aligned. Figure-7 presents the resulting time series of discharge from downstream of Singda Dam upto Humps Bridge at various chainages and illustrates the impact of channel routing on the discharge. Using Mike 11 model, water levels were generated at several critical locations of Nambul River to check if the channel capacity was likely to be exceeded by routing the design flood after channel improvement. The water surface profile generated by modelling is shown in Figure-9.

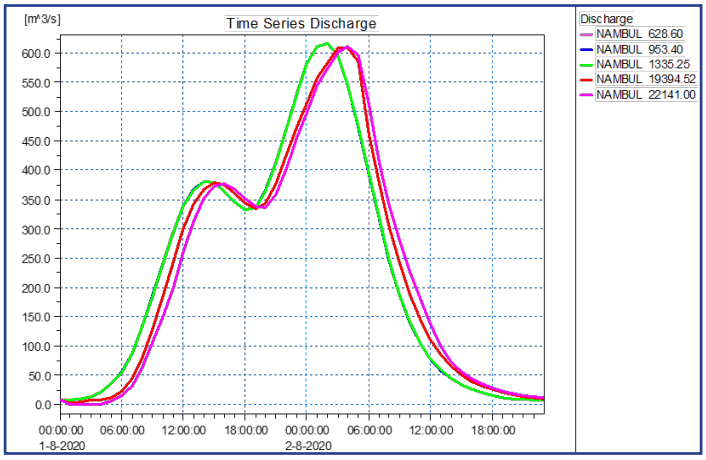


Figure 8: Time Series discharge due to Channel routing of 100-year flood.

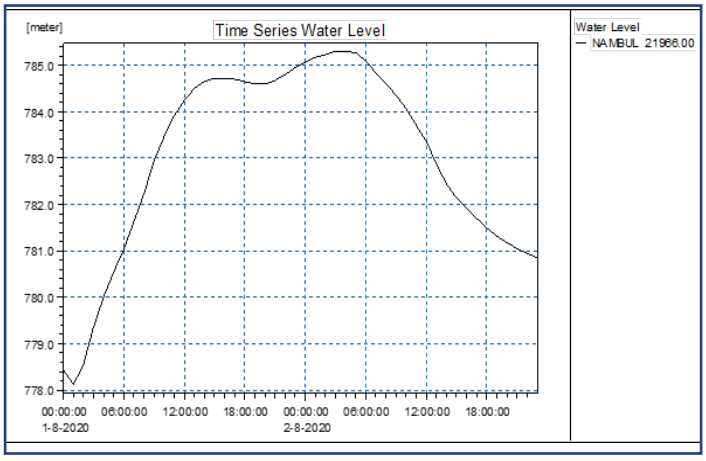


Figure 9: Typical plot of Water Levels by routing 100-yr flood at Chainage 21966 m.

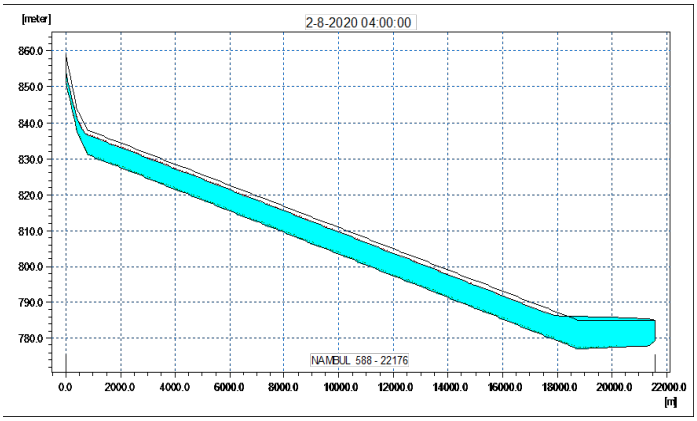


Figure 10: Plot of Maximum water surface profile due to 100 yr flood in Nambul River

In an earlier study carried out by DHI, the integrated modelling of the whole system including channel below Singda Dam, Samushang drain and Nambul River was carried out using the MIKE 11 software. The study was used to check the remodelled x-sections and a model study was used to check that design flood of 100-yr return period will be confined within the channel within the banks of remodelled Samushang drain and Nambul River.

At Samushang regulator, (i.e., near the junction of Samushang nala and Nambul River), the sill level of control structure with radial gate was decided as 779 m and was provided to store some stormwater in the Samushang drain during high flow conditions in the Nambul. That would take care of the possibility of flooding towards the end of the Nambul River for episodic event of 100 yr. flood as seen from the results presented in Figure-9. Besides that, an emergency pumping option was also provided at the regulator, which allows starting of pumping when water level in the Samushang exceeds a particular level.

Sizing of Reservoir

The decision on the size of proposed reservoir was based upon the criterion that it should be large enough to contain a 100 yr. flood and should also have sufficient water for conservation use as well. The volume of flood of 100 yr return period was assessed as 5.82 MCM. Further, the water availability was assessed at 75% dependability for Lamphelpat catchment, which would fall into the reservoir, was assessed as 11.78 MCM. Based upon that, it would be justifiable to develop a water reservoir of the size of 12 MCM for flood management as well as meeting some irrigation demands, tourism and creation of a biodiversity park around the proposed reservoir.

Conclusions

The paper demonstrates use of a combination of traditional hydrological analysis of synthetic hydrograph analysis, water availability study and modern hydrodynamic modelling tools for providing effective solutions for flood management, conservation, improvement of environment, recreation and biodiversity.

Imphal city needs to adopt an improved planning process, and profit from the multiple co-benefits generated by the interventions. Aside from increased retention capacity these interventions provide space to recreate and complement the urban ecological corridors. They are also expected to improve the air quality. Additionally, as a result of the urban upgrading, the Green Infrastructure is expected to create land value. The water body was also proposed to be used for recreation, pisciculture and recreation. The biodiversity park planned around the reservoir area would certainly improve the environment and promote ecotourism. The availability of reliable water supply for irrigation in the neighbouring areas would add to the income of farmers and horticulturists and improve the overall aesthetics and overall environment of the area. The model is replicable for similar cities which have wetlands/ open areas available around them. It is projected that by the end of 2030, about 40.76% of India's population would live in the cities. The idea presented in this paper could also be used for systematic planning of new urban areas to manage flood control and cater to increased demand of water in such areas in an environmentally friendly manner.

Acknowledgment

Authors duly acknowledge the support and help provided by the Department of Water Resources, Government of Manipur during the preparation of the Detailed Project Report.

C2S2

Cetus Consulting Solution Services Pvt. Ltd (C2S2) is dedicated towards finding innovative and appropriate solutions for sustainable development of water resource development. This essentially entails management of water resources quantity and quality with minimal impact on the environment and biodiversity. C2S2 deals with the multi-faceted nature of water management in several fields like Irrigation, Water Resource Management, Disaster Management, Environment Management, Waste Water Management, River Basin Management, Dams & Reservoirs, Development of River Basin Management Plans, Watershed Management, Natural Resource Management, Energy and Chemicals, Infrastructure and Urban Planning, Maritime Engineering, Climate Change, Internet of Things (IoT) application in monitoring and managing project and Geotechnical Engineering application. C2S2 has undertaken a number of projects in India and Nepal. The main ones being Urban Flood Management and Rejuvenation of Amanhusha River, Jaipur, Rajasthan; Reservoir Optimisation and Operations for DVC Project Dams; Feasibility and Engineering of Riverine Jettys and Inland Navigation in Mahanadi and Bramhani Rivers; Technical and Feasibility for Modhwa Port for Coal Import; Lamphelpat Rejuvenation and Flood Management in Imphal, Manipur; Internet of Things (IoT) for Crop Water Management in Rice and Wheat in Punjab; Climate Change and Delta Irrigation and Flood Management in Cauvery River; Watershed Management and Agricultural Development in Rajasthan; Design and Development for Canal Automation in Gandak Canal, Uttar Pradesh; Design of Hydrological Information Systems in Vindyanchal and Bundelkhand region, Uttar Pradesh; Survey, Mapping and Design of Hill Slope Analysis for Building Resilience against Landslide for improving the connectivity to Darjleeing, North Bengal; Technical Design Basis for Water Supply Tunnel in Melamchi Water Supply, Nepal; etc

Exploiting Online Data to Complete a Rapid Multi-Hazard Risk Assessment in a Data Poor Environment

Tom Burkitt
Director – Risk & Insurance

Michael Meadows
Senior Hydrologist
DHI Water and Environment

Abstract

Exposure and vulnerability are inherently dynamic, and Uttarakhand (India) demonstrates that very well. Over the past 25 years there has been an emphasis on stimulating and nurturing economic growth and development, resulting in many benefits, but also a remarkable increase in the exposure of urban areas and rural communities, infrastructure, and the economy overall.

Uttarakhand is investing to improve response and Disaster Risk Reduction (DRR). For instance, the Disaster Risk Assessment of Uttarakhand (DRA) is an 18-month project funded by the World Bank that completed a statewide probabilistic assessment of risk arising from five potentially catastrophic types of hazards: earthquakes, floods, flash floods, landslides, and large-scale industrial hazards.

This paper highlights the difficulties of 'hitting the ground running' with this ambitious assessment, and describes two innovative and replicable techniques to achieve a suitable level of coverage for the exposure assessment.
Keywords: Disaster Risk Assessment, Uttarakhand, Risk Reduction, Resilience, Exposure.

1 Introduction

This paper describes innovative and replicable techniques used by the team on the Disaster Risk Assessment of Uttarakhand to overcome technical challenges when compiling data on the exposure and vulnerability of buildings and people (specifically tourists).

1.1 Uttarakhand

Uttarakhand is highly susceptible to natural hazards, including earthquakes, fluvial floods, flash floods, and landslides. It is situated in Northern India, bordered by Nepal and China (Tibet), and several large and active seismic fault lines bisect the state. Heavy rainfall and steep terrain in the hilly areas exacerbate flash flooding risks, and landslides are of very frequent occurrences, thereby threatening lives and requiring costly regular repairs to infrastructure.

Exposure in the state is highly dynamic in space and time, and Uttarakhand's population is growing rapidly. It is industrializing and urbanizing at a rapid rate, with urban areas drawing an increasing number of people from the more remote and hilly rural areas. Over time, these trends continue to increase the exposure of urban communities to hazards, particularly flooding and earthquakes.

There are approximately 110 urban agglomerations listed in Uttarakhand under the 2011 census and these vary in size significantly. Dehradun is the largest with an estimated population of 600,000 people in 2017, and the top 30 urban areas comprise 75% of the total urban population of the state. The urban systems are characterized by rapid expansion in the past 40 years, unchecked development in many instances, seasonal fluctuations in the transient population due to tourism, aging infrastructure, and relatively poor conditions of civil transport and networks. Standards of construction quality vary due to poor enforcement of building codes, and asset maintenance and management is generally poor. However, Uttarakhand is a highly literate state with a well-educated population, reasonable state GDP, and a high standard of living relative to other states in India. There are also high rates of penetration and uptake of new technologies (for instance, smart phones, e-commerce, and coverage of digital communications).

All of these disparate factors and others combine and interact to create a complex and dynamic profile of risk and resilience across the state's urban areas.

1.2 *Composition of risk and the disaster risk management cycle*

In catastrophe hazard modelling, risk is defined as the product of 1) hazard susceptibility and severity, 2) exposure (both economic and human), and 3) the vulnerability of infrastructure and the human population. Adaptive capacity is a sub-component of vulnerability and represents the ability of the community, asset, or entity to adapt to the impacts of a hazard and thus reduce its inherent vulnerability in future. Effective disaster risk management is a defining characteristic of resilient societies and

a resilient community is able to manage and limit exposure to threats, minimize its vulnerability, and is able to adapt reasonably well. Impacts of hazards on communities, economies, and systems are both direct and indirect, and probabilistic risk assessment aims to understand these impacts and identify which factors contribute most to the overall risk for a given location, type of asset, community or source of revenue.

A useful cyclical framework for Disaster Risk Management is illustrated in Figure-1. This is, in theory, a virtuous and fully integrated cycle, where improvements in each phase of the cycle should increase resilience in communities over time, and risk assessment and analysis are components of mitigation in the cycle. Effective mitigation defines actionable mid to long term responses and interventions to minimize the risk posed by uncertain future events.

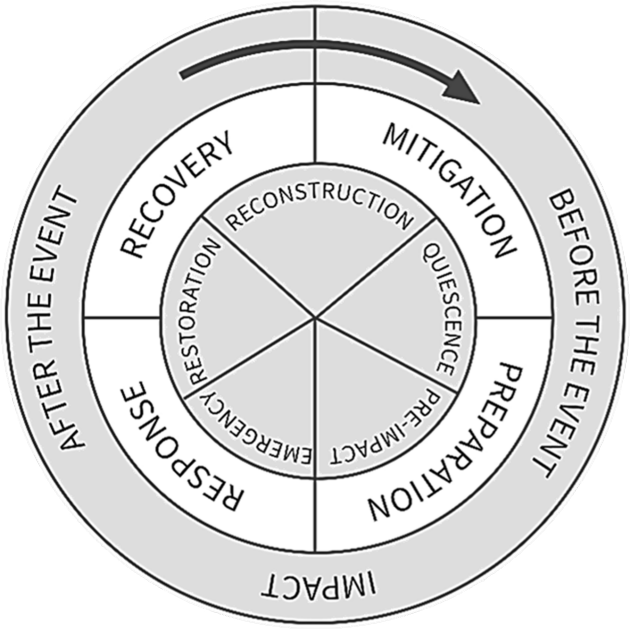


Figure-1. A schematic representation of the Disaster Risk Management Cycle (from Alexander, D.E., Principles of Emergency Planning and Management, Oxford University Press Inc, USA, 2002)

2 The Disaster Risk Assessment of Uttarakhand

Hazards themselves are very difficult or, in the case of earthquakes, presently impossible to prevent from occurring or to mitigate or control directly. In Uttarakhand, the priority of the World Bank funded Disaster Risk Assessment of Uttarakhand was to reduce risk and build resilience by focusing on reduction of ***exposure*** and ***vulnerability***, whilst exploring how to build adaptive capacity.

There is a very high dependency on primary and secondary data for the hazard modelling and for the development of the exposure and vulnerability data sets, and risk assessments often stimulate innovation in data acquisition. The approach adopted was to leverage trusted secondary sources of data as much as possible, but that presented a huge challenge in itself and most available data lacked either completeness or coverage. Examples of two techniques that were used during the study to build adequate exposure datasets with appropriate detail and coverage of data for buildings across the state and to understand tourist spatial and temporal aggregation are also given.

3 Innovative Approaches to Scaling-up Exposure Data

Two specific technical challenges that the project faced were 1) to ensure sufficient coverage of building level information and b) to understand the movement (spatial and temporal) of tourists across the state.

3.1 *Predictive analysis of building typologies and vulnerabilities across the state*

The predominant building type in a settlement (town or village) heavily influences its risk profile. For this reason, it was essential to identify the various building typologies found around the state and then map their distribution in as much detail as possible.

Based on preliminary field surveys and consultation with local experts, we confirmed fifteen (15) typologies or structural classes as being sufficiently representative of the state's structural diversity. Vulnerability curves were developed for each typology in order to estimate the expected damage resulting from the different levels of hazard intensity measure in Peak Ground Acceleration (PGA) for earthquakes and water depths and velocities for flooding.

The remaining and formidable challenge was to map the distribution of each typology across the entire state and to do this rapidly and with sufficient accuracy. This was not possible using field surveys alone given the short timeframe, and attempts to map each typology individually using remotely-sensed imagery failed, due primarily to the lack of a correlation between typology and roof material (or any other building property visible from space) as well as the prohibitively high cost of high-resolution imagery.

Instead, the project team built a web-based collaborative and "crowd-sourcing" application, whereby trained volunteers quickly traced and demarcated built-up areas and isolated building clusters manually, using a backdrop of lower-resolution yet appropriate and freely available satellite imagery. Within 5 weeks, building clusters in over 73,000 tiles were digitized successfully. Systematic quality assurance measures ensured the reliability of this impressively detailed dataset of built areas and building clusters across the whole state.

The team then developed probability regression models to predict the relative proportion of building types in any given building cluster. First to be surveyed were the 425 settlements (towns or villages) and over 23,000 individual buildings across all 13 districts in the state to characterize the type and vulnerability function. The intent was to ensure coverage of the full diversity of the state's buildings: urban and rural areas, hills and plains, accessible and remote.

Using the functionality built-in to the R statistical package, the models were optimized to correlate 600 predictors from the authoritative 2011 census of settlements with the observed data. The census was limited to administrative settlement boundaries that were an inappropriate scale for exposure assessment, but the geospatial resolution and value of the data were improved by attributing predicted results for settlements to the individual building clusters for each settlement. That ensured that the exposure was not overstated.

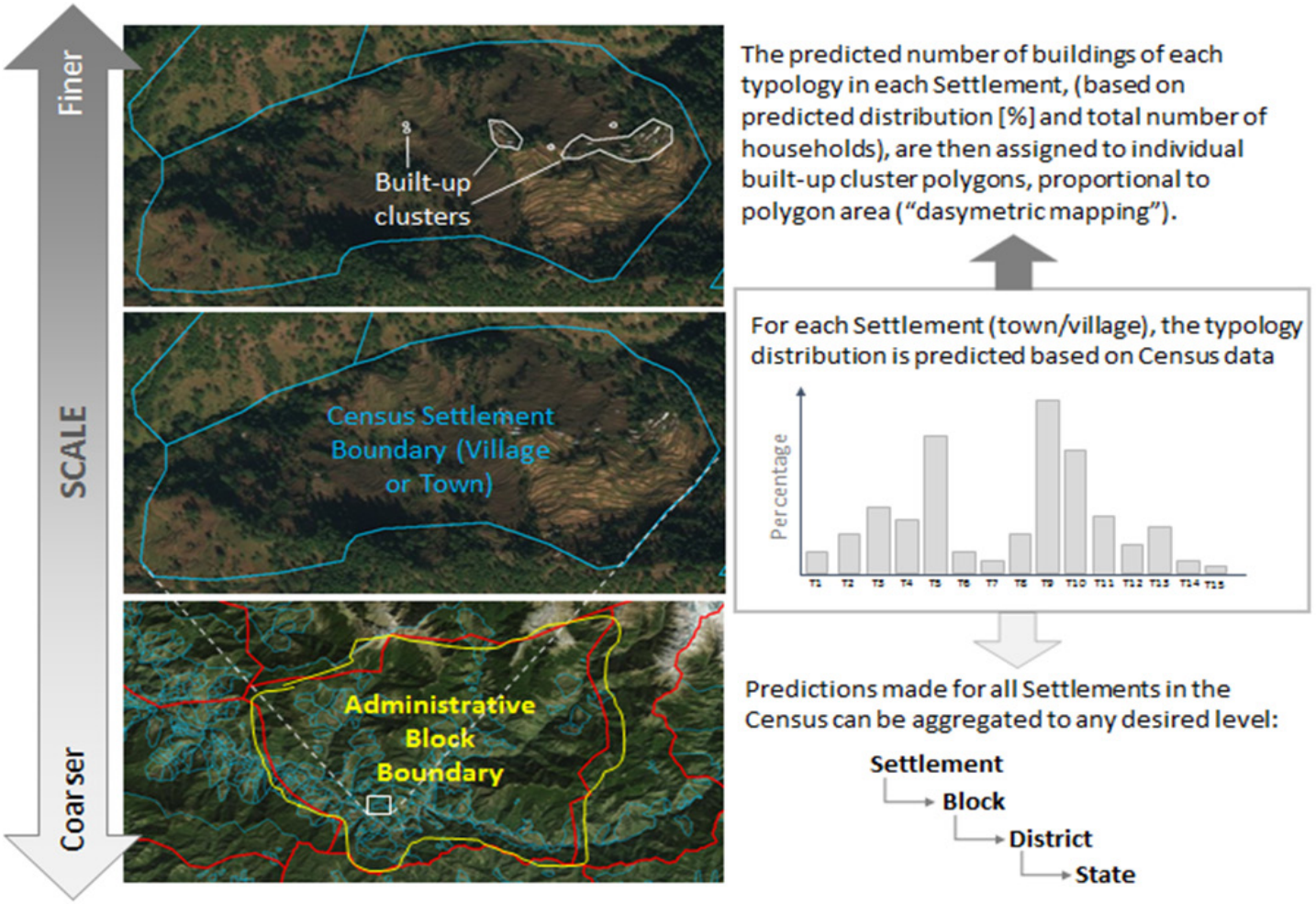


Figure-2. Results of the predictive model for building typology distribution and exposure.

In a relatively short period of time, that approach enabled the project team to produce a detailed map of Uttarakhand's structural diversity; an essential component for the state-wide risk assessment. Figure-2 illustrates an example of the final output and how the information could be aggregated up from building cluster to different scales.

3.2 *Web crawling to expand understanding of tourist exposure*

Official statistics exist giving the number of total annual visitors for major tourism destinations, but that data provided no information about the spatial and temporal distribution of tourists over the course of a year or where they may cluster. Additionally, Uttarakhand lacks a geospatial inventory of hostels, hotels, and guesthouses.

The approach to overcome these limitations quickly was to mine the wealth of information freely available online. Thus, the focus was on two main types of website; namely booking/review websites like Booking.com and social media sites hosting photos (for instance, Flikr and Instagram). These data sources have inaccuracies, but they have proven to have usable and valuable metadata, good scale and coverage in 2017 (that coverage is growing), and they have proven sufficiently reliable for defining aggregated zones or "hotspots" of tourism activity in spatial and temporal terms. The data of these zones were corroborated by other sources and through stakeholder consultation.

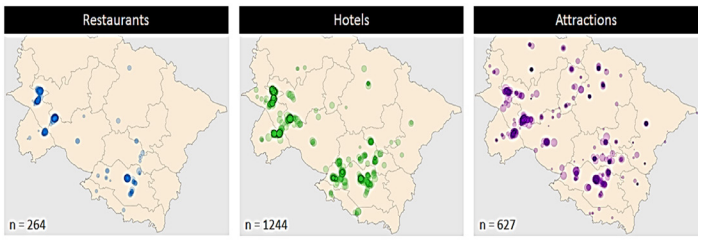


Figure-3: Example of cluster for establishments extracted from Trip Advisor. Marker size is proportional to the number of reviews, an indicator of popularity.

The script extracted available data, including the date, time, location, and categorization of the establishment or site. Additional metadata varied in quantity and quality with type, but generally included a number of reviews – as a rough indication of popularity – and a qualitative measure of how expensive that site was, relative to other options in the state. The team processed the data to remove duplicates and ignore outliers for location, but most inaccuracies were tolerable given that the intention was to derive 'activity zones' rather than precise points for specific establishments.

An increasing number of photographs are posted to social media sites on a daily basis, and many of these photographs have embedded metadata showing exactly where and when the photo was taken. It was an invaluable resource. While some social media platforms strip out this metadata information by default, others retain it or leave it up to the person uploading the photograph to decide. An example of the latter type is Flickr, where users have uploaded almost 55,000 geotagged photographs taken in different parts of Uttarakhand, providing a fascinating insight into the attractions and events frequented in recent years.

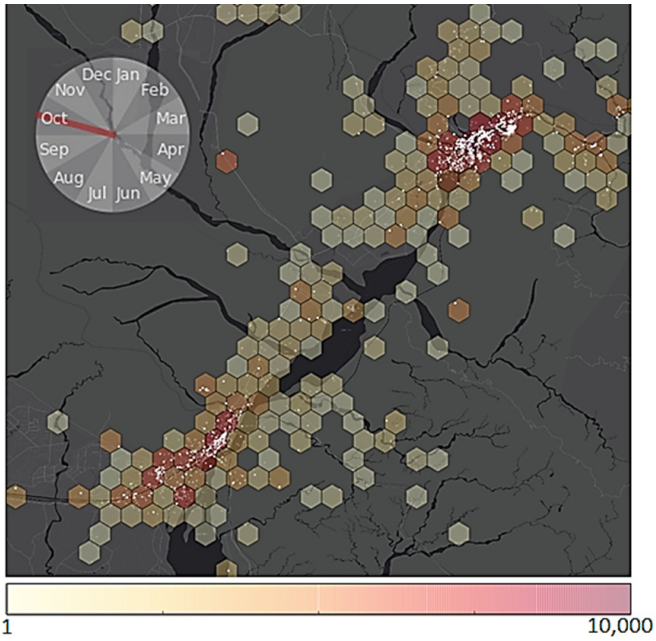


Figure-4: Geotagged photographs (white spots) as a proxy of tourism spatial and temporal clustering in the urban areas of Rishikesh and Haridwar. Hexagon colour represents density of photographs and the scale is logarithmic. The temporal dimension is by month.

As an example, Figure-4 shows all geotagged photographs taken in the month of October, in and around the towns of Haridwar and Rishikesh, which are significant sites of Hindu pilgrimage. Individual photograph locations were also used and a hexagonal bin heatmap was also plotted indicating relative concentrations of tourism activity in the area.

As is the case for information extracted from booking/review websites, the quality of metadata for photographs was variable and there were some limitations. For example, they did not necessarily correspond to tourist activity, as local people who want to share an interesting aspect of their own town or village would also take photos. Additionally, the useful data was limited to those individuals with access to a GPS-enabled device such as a smartphone, meaning only a subset of the entire tourist population was represented. The data also only indicated locations deemed "photo-worthy", rather than representing a full log of everywhere that tourists might spend their time while travelling around the state.

Despite these limitations, these datasets have both provided useful information on likely tourist distributions that would otherwise be difficult or impossible to estimate. By using relative densities of hotels, photographs, etc. rather than absolute numbers, it was possible to define and differentiate tourism activity zones with a reasonable degree of confidence.

4 Linkages to urban resilience

In this paper, two simple approaches that illustrate leveraging the power of social media and online content aggregators to scale up coverage and supplement existing data on infrastructure and visitor exposure in urban and rural locations. The data gave a better understanding of the spatial and temporal variabilities across the state, and that allowed the team to define better structural and non-structural interventions to reduce risk and build resilience.

Rapid digitization and increased connectivity provide opportunities to exploit social networks, big data, and machine learning throughout the Disaster Risk Management Cycle (Figure-1). However, it was observed that decision-makers presently lack capacity and understanding to exploit these opportunities fully or plan to avert any emergent threats. However, it is recognized that Uttarakhand's socioeconomic standing is such that it has the potential to leverage new technologies and become a digital leader in the risk management domain.

DHI's Experience:

DHI Water & Environment (DHI) is a global non-profit consulting and research organisation that has been in operation for over 55 years and has approximately 1200 staff operating out of over 25 offices globally. DHI specialises in solving water-related challenges- be it a river, a reservoir, an ocean, a coastline, within a city or a factory and is one of the world's leading hydrological and flood risk management organisations. DHI's world is water. So, whether there is need to save water, share it fairly, improve its quality, quantify its impact or manage its flow, DHI can help. DHI's knowledge, combined with their team's expertise and the power of their technology, holds the key to unlocking the right solution.

DHI recently delivered the Disaster Risk Assessment of Uttarakhand in India for the World Bank Group and is also delivering a programme in Bhutan to Strengthen National Disaster Risk Assessment and Management Systems.

Integrated Storm Water Drainage System in Project Areas of Dehradun City

Jitendra Tyagi
Senior Manager - Environment
Tata Consulting Engineers Limited

Sanjay L Lalan
General Manager – Environment
Tata Consulting Engineers Limited

Abhijit Thalpate
Assistant Manager – Civil
TATA Consulting Engineers Limited

Vinaykumar Mishra
Additional Program Director
Uttarakhand Urban Sector
Development Agency, Dehradun

INTRODUCTION

Dehradun, the capital city of Uttarakhand State has a municipal area of 206.16 sq.km and the present population is about 12 lakhs. Dehradun receives an average annual rainfall of about 2250 mm. It is surrounded by hills, has a natural drainage pattern and divided into ten storm water drainage zones with sufficient gradients to drain off storm water easily into the two main rivers namely Bindal and Rispana which pass through the city. The slope of both rivers is from North to South, whereas the city has a natural slope from North-east to South-west. The low lying area is mostly along River Bindal and a natural nala. The natural waterways, drains and the low lying areas are well connected to the River Bindal.

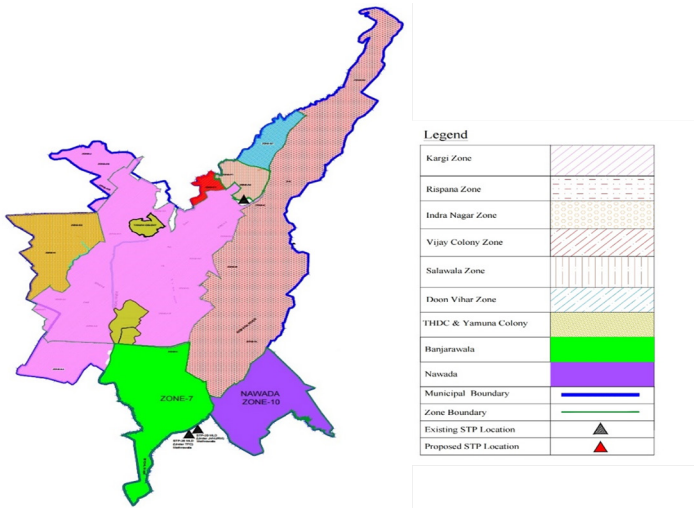


Figure-1: Catchment Area of Dehradun City

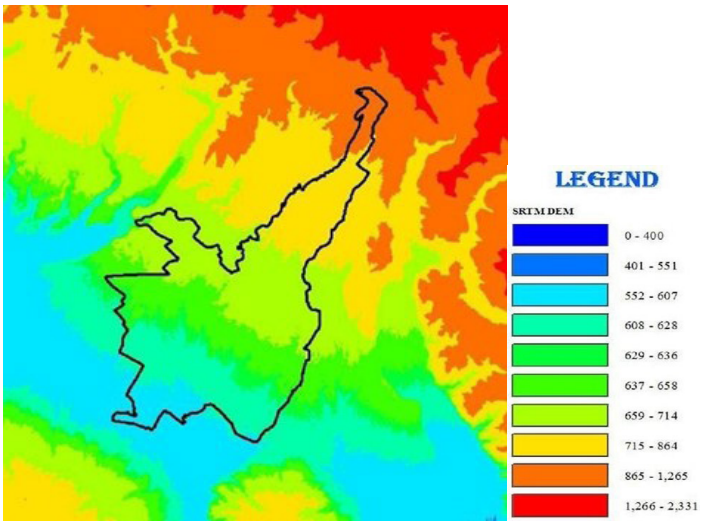


Figure-2: Digital Elevation Model of Dehradun City

Most of the roads in the town have existing road side drains except in the slums and the newly developed areas and parts of peripherals areas which have recently been included in the limits of the Nagar Nigam. In the last 20 years after being made the capital city, Dehradun city has urbanized at a fast rate and the surrounding area has been merged within the municipal area recently. These factors are now resulting in flooding and water logging which cause inconvenience and economic losses. There are existing drains in the project area however, they are chocked up, have missing links, plastering of some drains have been damaged/ peeled off, drain covers are missing, etc. Majority of the existing drains are open and some are unlined. Lack of regular de-silting and routine

resulted in reduction in the carrying capacity of the drains. Dumping of solid waste into the roadside drains is resulting in their getting choked.

There is no planned storm water drainage system in THDC, Yamuna Colony and Banjarawala areas of Dehradun city. The Storm water drainage network in the THDC colony is connected to main nallahs namely Manu Ganj nallah (Bhandari bagh) and the storm water from THDC and Yamuna Colony ultimately discharges into River Bindal. The existing roadside drains are in poor conditions and need to be designed hydraulically with a holistic approach. During the rainy season there is flooding and unhygienic conditions prevail. To overcome that, an integrated storm water drainage system has been proposed in the project areas of Dehradun city namely THDC colony, Yamuna colony and Banjarawala. Routine cleaning and maintenance activities of road side drains are carried out by the Dehradun Nagar Nigam.

Based on the natural topography and orientation of the receiving water body, the outfalls have been proposed in natural drains and River Bindal. The contributory area for the different reaches of the drains were demarcated on the topographical and contour surveys maps. An Integrated Storm Water Drainage (SWD) system was proposed to prevent flooding by conveying the storm runoff into drains as per the natural topography. Based on the study, the following works were identified in the project area:

- Drainage improvement works such as plastering, repairs, replacement of damaged drains,
- Improvement works such as cleaning and de-silting of drains,
- New roadside drains wherever non exist,
- Rain water harvesting system in Government buildings and STP premises,
- Recharging pits in storm water's secondary and primary drains, and
- Covering of drains.

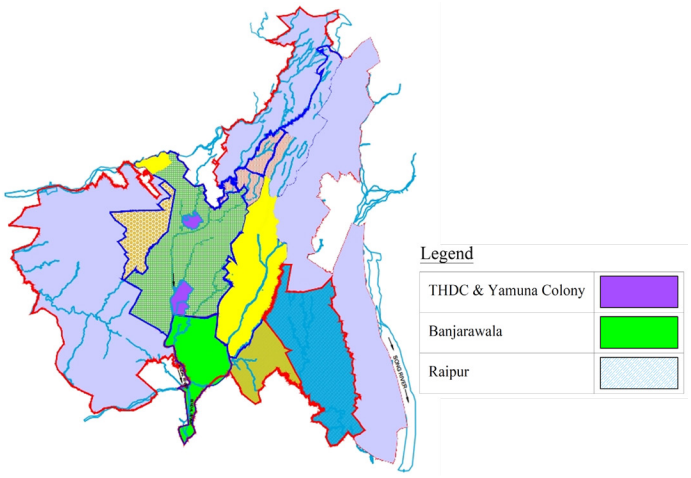


Figure-3: Map showing Project area in Dehradun City

The runoff was computed for each drainage zone and sub catchments of the project area. As per the recommendations in CPHEEO Manual, a return period of 2 years was adopted for the estimation of the runoff. The rainfall data was collected from the Indian Meteorological Department for Dehradun for a period of 25 years and the same was adopted for designing the storm water drains. Rainfall analysis was carried out from the available rainfall data and mathematical methods such as Gumbel's Distribution Method and Annual Exceedance Method were used for the computation of the intensity, duration and frequency of the storms. Gumbel's Distribution Method was selected for Dehradun city.

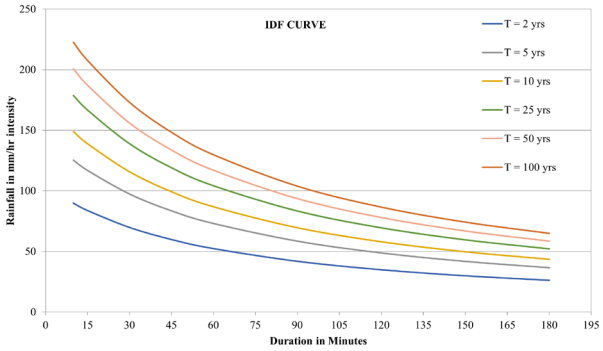


Figure-4: Intensity Duration Frequency Curve

Brick masonry drains were proposed for drain upto a depth of 0.8m and RCC drains for those whose depth was more than 0.8m. Drains were designed to achieve a minimum self-cleaning velocity of 0.6 m/sec at the design flow and a limiting maximum velocity of about 3 m/sec for RCC drains. The minimum width of the drain was 250 mm. The hydraulic designs were carried out using Manning's formula for the open channel flow. Hydraulic modeling was done using StormCAD software.

Based on the natural topography, six drainage sub-zones were formed in the Banjarawala area as shown in Figure-5.

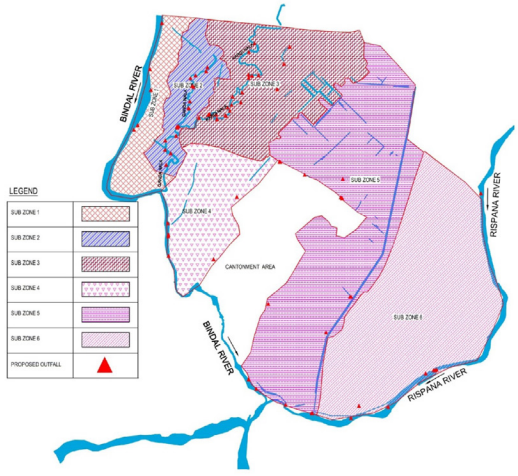


Figure-5: Drainage sub zones in Banjarawala Project area of Dehradun City

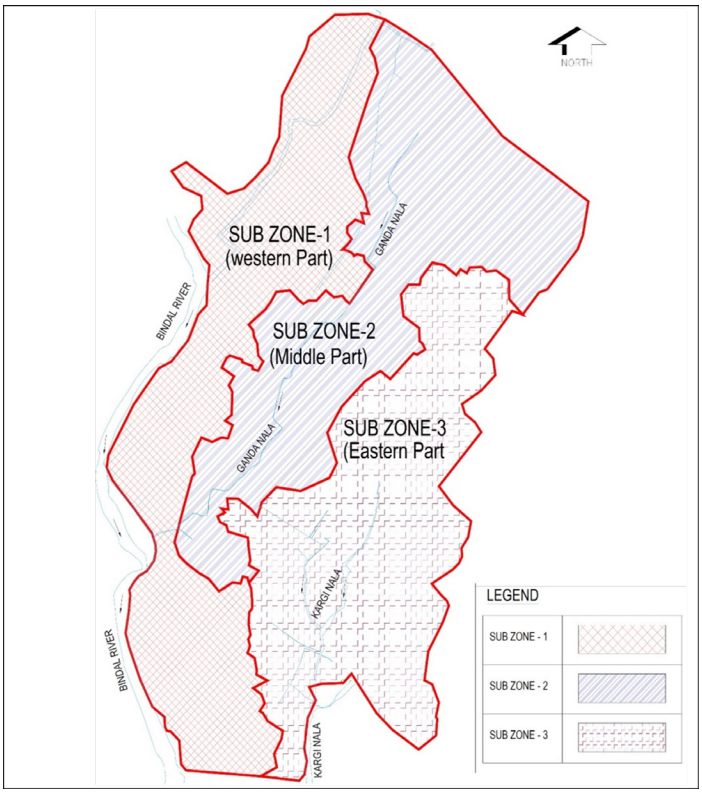


Figure-6: Drainage sub zones in THDC, Yamuna colony Project areas of Dehradun City

As per the natural topography, the project areas of THDC and Yamuna colony fell into a single zone which was further divided into three drainage Sub-Zones as follows:

Sub-Zone 1: Contributing from the western part of the project area and directly discharging into Bindal River.

Sub-Zone 2: Contributing from the middle part of the project area and discharging into Ganda Nala which ultimately discharges into River Bindal.

Sub-Zone 3: Contributing from the eastern part of the project area and discharging into Kargi Nala which ultimately discharges into River Bindal.

Improvements in Storm Water Drainage System

The integrated storm water drainage system proposed, utilized the existing drains which were in good conditions. Improvement of existing drains was proposed for plastering work, repair work, covering of drains and replacement of damaged drains. The new road side drains were proposed wherever they did not exist. The network of tertiary drains was connected to secondary and primary drains to ensure 100% collection of surface runoff from road surface in project area and conveying it to the river through outfalls and thus improve the service levels. There would be savings in the project cost by utilizing the existing drains. The following suggestions were made in the project area.

1. Rainwater Harvesting Pits for Ground Water Recharge in Secondary and Primary Drains

Ground water recharge pits have been recommended inside primary and secondary drains area by the side of the storm water drains. Suitable arrangement is made so that the overflow from these drains flows into these recharge pits at every 500m intervals along the stream. The typical arrangement of the Rainwater harvesting structure is shown in Figure-7.

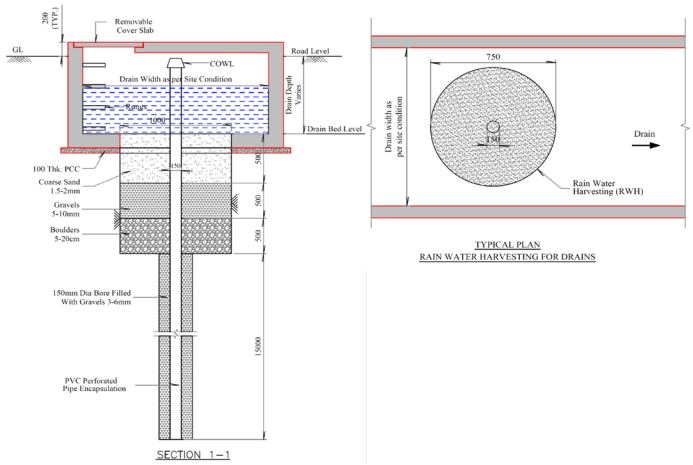


Figure-7: Typical details of Rain water harvesting structure (All dimensions are in mm)

2. Rain water harvesting system in Government buildings and STP premises in project area

Rain water harvesting system was proposed for Government buildings and the STP premises in the project area. Rain water collection system to be provided for roof of Government buildings and the STP premises and collected into rain water storage tank after online filtration. The stored rain water could be used for gardening within the campus.

3. Reutilisation of Soak Pits as Ground Water Recharge structure

The project area has septic tanks and soak pits in individual houses since there is no piped sewer system. An integrated sewerage system was proposed in the project area along with storm water drainage system; house service connections were also proposed. After commissioning of the proposed system, the existing soak pits would be defunct. It was proposed to reutilize the soak pit after cleaning, disinfection and providing filter media so they could be used as ground water recharge structures. It would be implemented in a pilot area of the project area in Banjarawala.

4. Outfalls

The existing outfalls would be provided with silt trap and trash screen so preventing silt and floating matters entering into the River. For the rain water however, free fall discharge of runoff is proposed from the outfalls into river. That would prevent flooding and backflow of water during the rainy season.

5. Kerb channels in narrow lanes in Raipur area

Kerb channels were proposed in existing narrow lanes where there are no road side drains in the Raipur area on a pilot basis. That would ensure

smooth collection of surface runoff from road surface and lead it to the Kerb Channel drains and ultimately connected to existing drainage network for disposal. That would prevent road damage and cost towards road maintenance would be reduced in the narrow lanes.

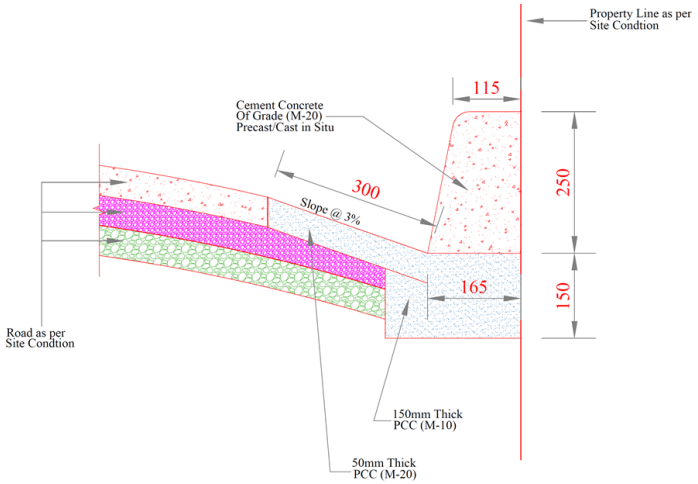


Figure-8: Typical details of Kerb Channels (All dimensions are in mm)

6. GIS Mapping of Storm Water Drainage infrastructures

GIS mapping of the storm water drainage infrastructure was proposed in the project area to capture all the existing and proposed assets on a GIS platform. That would benefit for the planning for future investment, data base management, effective operation and maintenance service and improving the service levels.

RECOMMENDATIONS

• The digital elevation model would be very useful for understanding the topography of the terrain and the catchment study.

• Rainfall analysis and selection of mathematical model are critical for the development of IDF curve and designing of drains and be decided based on rainfall pattern, rainfall data, terrain catchment and prevailing site conditions.

• It is important to study the existing storm water drainage system, identification of gaps and challenges and O&M issues faced by the ULB. It would assist in providing sustainable and cost effective solutions.

• Ground Water Recharge should be initiated by constructing recharge pits in primary and secondary drains, rain water harvesting system in Government buildings and complex for recharging the ground water table and also act as a flood control measure.

• Operation and Maintenance are important aspects and should be included in the project along with implementation of the proposed storm water drainage infrastructures for effective functioning of the assets.

• GIS mapping of storm water drainage infrastructure would provide very useful information for future planning, data management, routine maintenance work and for carrying out operation and maintenance service.

CONCLUSIONS

An integrated storm water drainage system was proposed based on catchment study as per topographical and contour surveys. Network modeling software StormCAD was used for analysis, design and network design optimization. The measures proposed for effective storm water drainage system were recharging pits in primary and secondary channels for ground water recharge which would also prevent flooding. The outfalls proposed with silt traps to avoid solid waste entry into the drains and trash screens. For narrow lanes, precast kerb channel drains were proposed in Raipur area of Dehradun. Reutilization of Soak Pits as ground water recharge structure was also proposed after cleaning, disinfection and filling with media in pilot basis in Banjarawala area. The proposed works are the replacement of existing drains which are not in good condition, repair works and plastering of drains. Cleaning and desilting of drains was also proposed for utilization of existing drains for catering to the design runoff and project cost saving. For the areas, which did not have road side drains the same were proposed to be provided and integrated with the drainage network. Drains with covers were proposed in busy streets. A five years O&M period after implementation of the SWD system was proposed for the project area.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the cooperation given by the Uttarakhand Urban Sector Development Agency (UUSDA) and Dehradun Municipal Corporation throughout the project period to TATA Consulting Engineers Limited and for allowing this article to be submitted based on the project data.

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4. IRC: SP: 42 - 2014 - Guidelines of Road Drainage

5. Master Plan of Dehradun City

6. Reports and maps available with Dehradun Municipal Corporation

TATA Consulting Engineers Limited

TCE has been involved for decades with Water, Wastewater and Stormwater Drainage projects in India and abroad for improving the living conditions of the habitants. Some of the Storm Water Drainage Projects are:

1. Design and Supervision Consultancy Services for Storm Water Drainage projects in Bikaner and Jodhpur cities, Rajasthan.
2. Design and Supervision Consultancy Services for Storm Water Drainage improvement for Patra Nallah zone in Bhopal city, Madhya Pradesh
3. Consultancy Services for preparation of DPR for Storm Water Drainage System for Tirupur City, Tamil Nadu.
4. Consultancy Services for preparation of DPR for Storm Water Drainage System for Salem City, Tamil Nadu.
5. Consultancy Services for preparation of DPR for Storm Water Drainage System for Boroughs IX and XV in Kolkata city, West Bengal

Climate Change Impact on Water Power in Himalayan Region: A Case Study for Chamoli District in Uttarakhand

Varun Aggarwal
Student
M. Tech Hydraulics and Water Resources
Delhi Technological University

Dr. Ajay Pradhan
Corresponding Author
President and CEO
Cetus Consulting Solution Services Pvt Ltd.

Dr. T. Vijaya Kumar
Associate Professor
Department of Civil Engineering
Delhi Technological University

ABSTRACT

The objective of the present project under study is to carry out the impact of climate change on Water Power (Hydro Power) Projects in the high Himalayan region. The study area is confined to the Chamoli District of Uttarakhand, which is an important area with many sacred places of worship. The area happens to lie in the most active seismic region of Himalayas with frequent tremors, heavy rainfall (including cloud bursts), landslides, avalanches and consequent floods. The water availability study in the major rivers and basins of the District have been discussed and presented based on precipitation and glacial melt. The study also discussed the hydrometeorology and hydrogeology of Chamoli District. The present study is mostly confined to research conducted through data and literature on different methods of hydrological analysis in mountainous regions. They include glaciological mass balance measurement, geodetic mass balance measurement, hydrological mass balance measurement and remote sensing measurements. Hydropower or Water Power potential of the region which includes the existing projects, ongoing works and future projects have been analysed and presented in this paper. A detailed review and analysis on environmental, ecological, physical and geological issues relating to hydropower projects have also been discussed. They include the impact on hydropower projects due to landslide induced sediment load, Glacial Lake Outburst Flood (GLOF), glacier break or avalanches, catchment area erosion due to seismic activity and snow/ glacial melt due to rise in temperature rises as an effect of climate changes. Finally, the study also highlights the recent disasters in Uttarakhand and especially in the Chamoli District of the high mountainous region of the Himalayas.

Keywords: Climate Change Impact, Water Power, Hydrological Analysis

INTRODUCTION

The great Himalayan region also called the roof of the world is the source of ten of the largest rivers in Asia listed in Table-1. It is being impacted by climate change which inter alia includes rapid reduction in glaciers.

	River		River basin			
River	Annual mean discharge m^3/sec^a	% of glacier melt in river flow[b]	Basin area (km^2)	Population density (pers/km^2)	Population x1000	Water availability (m^3/person/year)
Amu Darya	1,376[a]	not available	534,739	39	20,855	2,081
Brahmaputra	21,261[a]	~ 12	651,335	182	118,543	5,656
Ganges	12,037[a]	~ 9	1,016,124	401	407,466	932
Indus	5,533	up to 50	1081,718	165	178,483	978
Irrawaddy	8,024	not available	413,710	79	32,683	7,742
Mekong	9,001[a]	~ 7	805,604	71	57,198	4,963
Salween	1,494	~ 9	271,914	22	5,982	7,876
Tarim	1,262	up to 50	1,152,448	7	8,067	4,933
Yangtze	28,811[a]	~ 18	1,722,193	214	368,549	2,465
Yellow	1,438[a]	~ 2	944,970	156	147,415	308
Total					1,345,241	

[a] The data were collected by the Global Runoff Data Centre (GRDC) from the following most downstream stations of the river basins: Chatly (Amu Darya), Bahadurabad (Brahmaputra), Farakka (Ganges), Pakse (Mekong), Datong (Yangtze), Huayuankou (Yellow)
[b] Estimation of the meltwater contribution is difficult and varies in an upstream and downstream situation; approximates are given here.
Source: IUCN et al. 2003; Mi and Xie 2002; Chalise and Khanal 2001; Merz 2004; Tarar 1982; Kumar et al. 2007; Chen et al. 2007
Note: The hydrological data may differ depending on the location of the gauging stations. The contribution of glacial melt is based on limited data and should be taken as indicative only.

Table-1: Principal rivers in the Himalayan Region (Adapted from: The changing Himalayas: Impact of Climate Change on Water Resources and Livelihoods in the Greater Himalayas, ICIMOD)

Continuing climate change is predicted to lead to major changes in the strength and timing of the Asian monsoon, inner Asian high-pressure systems, and winter westerlies – the main systems affecting the climate of the Himalayan region. The impacts on river flows, groundwater recharge, natural hazards, and the ecosystem, as well as on the people and their livelihoods, could be dramatic, although not the same in terms of rate, intensity, or direction in all parts of the region. Given the current state of knowledge about climate change, determining the diversity of impacts is a challenge for researchers, and risk assessment is needed to guide future action.

Himalayan Climate and Water

The Himalayas display great climatic variability. The mountains act as a barrier to atmospheric circulation for both the summer monsoon and the winter westerlies. The summer monsoon dominates the climate, lasting eight months (March-October) in the eastern Himalayas, four months (June-September) in the central Himalayas, and two months (July-August) in the western Himalayas (Chalise and Khanal 2001). The east-west variation is based on the dominance of different weather systems, which in turn cause the monsoon to weaken from east to west. The orographic monsoon penetrates northwards along the Brahmaputra River into the southeast Tibetan Plateau, but rarely as far as the Karakoram range (Hofer and Messerli, 2006; Rees and Collins, 2006). The highest annual rainfall in the region occurs in Cherapunjee in India, amounting to more than 12,000 mm.

A substantial portion of the annual precipitation falls as snow, particularly at high altitudes i.e. above 3000 masl (meters above sea level), feeding the Himalayan glaciers. The high Himalayan and inner Asian ranges have the most highly glaciated areas outside the polar regions (Owen et al. 2002; Dyurgerov and Meier 2005). Glaciated areas in the greater Himalayan region cover an area of more than 112,000 km2 which is 18.824% of the total Himalayan Region, (Refer Table-2).

Mountain range	Area (km²)
Tien Shan	15,417
Pamir	12,260
Qilian Shan	1,930
Kunlun Shan	12,260
Karakoram	16,600
Qiantang Plateau	3,360
Tanggulla	2,210
Gandishi	620
Nianqingtangla	7,540
Hengduan	1,620
Himalayas	33,050
Hindu Kush	3,200
Hinduradsh	2,700
Total	112,767

Source: Dyurgerov and Meier 2005

Table-2: Glaciated area in the Upper Himalayan Region (Adapted from: The changing Himalayas: Impact of Climate Change on Water Resources and Livelihoods in the Greater Himalayas, ICIMOD)

The main melting occurs in high summer; however, when this coincides with the monsoon, it may not be as critical for water supply as when the melting occurs in the warmer seasons: spring and autumn. When the monsoon is weak, delayed, or fails, meltwater from snow and ice may limit or avert catastrophic drought. Water from both permanent snow and ice and seasonal snow is released by melting, some to be temporarily stored in high altitude wetlands and lakes, but most flowing directly downstream into the large river systems, giving a distinct seasonal rhythm to annual stream flow regimes in these rivers. The contribution of snow and glacial melt to the major rivers in the region ranges from 2% to 50% of the average flow.

MATERIALS AND METHOD

Study Area

Historical background

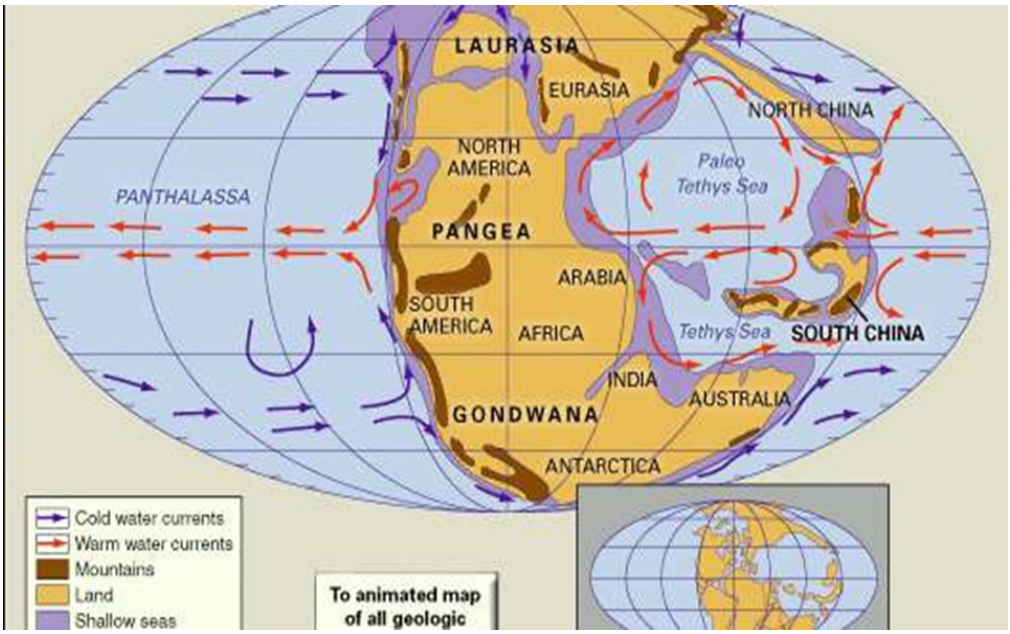
The region covered by the District of Chamoli (refer Figure-1) formed part of the District of Pauri Garhwal of the Kumaon till 1960. It occupies the north-eastern corner of the Garhwal tract and lies in the central or mid-Himalayas in the very heart of the snowy range described in ancient books as Bahirgiri, one of the three divisions of the Himalayan mountain ranges.

Figure-1: District map of Chamoli, Uttarakhand (Adapted from: Maps of India)

Geographical settings

The geology of the region shows that the Himalayas are young mountains. During early Mesozoic times, or the secondary geological period, the land mass now covered by them was occupied by great geosynclinals - the Tethys Sea, refer Figure-2.

The probable date of commencement of the elevation of the Himalayas is about the end of the Mesozoic period, but the unravelling of the story of their structure has only just begin, and in many cases no dating of the



Figre-2: Land mass during the early Mesozoic era
(Adapted from: C.R. Scotese, The University of Texas at Arlington)

rocks is yet possible, though they include ancient and relatively recent crystalline intrusive, rocks and sediments allied to the peninsular part of India.

The direction of folding in the mountain masses is generally North to South. The geological feature of the District, form two major divisions which lie North and South of an imaginary line extending East-South-East between the villages of Hilang in Joshimath and Loharkhet in the adjoining District of Pithoragarh. The Northern division, which is occupied by higher ranges and snow-covered peaks consist entirely of medium to high grade metamorphic rocks which have intrusions by later volcanic rocks. The Division to the South, has ranges of lower altitude, consists essentially of sedimentary and low-grade metamorphic rock also with intrusions of later volcanic rocks.

Weather and Climate

The climate varies from Sub-tropical monsoon type (mild winter, hot summer) to tropical upland type (mild winter, dry winter, short warm summer). The northern, northwestern, northeastern and western part of the District are perennially under snow cover, here the climate is of sub-arctic type in the areas with the lofty Himalayan Range. Severe winter and comparatively higher rainfall are the characteristic features of the northern part. The year may be divided into four seasons viz. the cold winter season, (December to February), the hot weather season (March to May), southwest monsoon season (June to September) followed by post monsoon season (October to November). The normal maximum and minimum temperatures vary between 31 ºC and –2.9 ºC respectively. Larger part of the District is situated on the southern slopes of the outer Himalayas. Monsoon currents penetrate through trenched valleys and the rainfall reaches its maximal in the monsoon season.

Seismic Activity

The seismic hazard map of India was updated in 2000 by the Bureau of Indian Standards (BIS). There are no major changes from the BIS 1984 map for the state of Uttarakhand. Districts along the borders with Nepal and China lie in Zone V. The Medvedev–Sponheuer–Karnik (MSK) intensities in excess of IX can be expected in these Districts. The rest of the state, including the city of Dehra Dun lie in Zone IV, where the maximum intensity expected could reach MSK VIII. Since the earthquake database in India is still incomplete, especially with regards to earthquakes prior to the historical period (before 1800 A.D.), these zones offer a rough guide of the earthquake hazard in any particular region and need to be regularly updated.

The Himalaya Range has been undergoing crustal shortening along the 2,400 km long northern edge of the Indian Plate which resulted in the formation of several thrust faults including the Main Central Thrust (MCT), the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT). The MCT consists of three sub-thrusts: MCT I, MCT II and MCT III. Many earthquakes have occurred along these thrust faults. The National Centre for Seismology (NCS), monitors earthquake activities in real time basis (24x7). It maintains a country wide seismological network, to detect and locate earthquakes occurring in and around the country. The network consists of state-of-art digital broadband seismographs, VSAT based communication systems and latest tools for dissemination of earthquake information to the concern Disaster Management Authorities and other user agencies in least possible time.

Hydrological Study in Mountainous Region

Glaciological mass balance measurement

A network of stakes and pits are placed on the glacier surface and used to measure the change in surface level while taking into account snow/fern/ice density. Comparing measurements between two fixed dates yields an annual mass balance, while comparing measurements at the end of the ablation and accumulation seasons yields a seasonal mass balance. The mass balance for the glacier is then estimated by multiplying the changes in mass balance at each sampling point with the area that point represents, and summing the product over the entire glacier. This method provides detailed information on the mass balance spatial variation and is considered more accurate than other methods.

Geodetic mass balance measurement

The geodetic method measures elevation changes of the glacial surface over time from various Digital Elevation Models (DEMs) constructed over the entire glacial surface. This method can be applied using topographic maps; DEMs are obtained by aircraft and satellite imagery, and by airborne laser scanning.

Hydrological mass balance measurement

The hydrological mass balance can also be used to estimate the glacial mass balance. The hydrological method uses a water-balance approach

to compute glacial mass balance. The estimated net precipitation in the basin is subtracted from the net runoff to compute the water storage within the basin, which is then interpreted as due to changes in glacial mass balance. The hydrological approach is difficult to use in the HKH (Hindu Kush Himalaya) area because of limited precipitation and discharge measurements.

Remote sensing measurements

Remote sensing measurements are based on information gained by aerial sensing technologies installed on aircraft and satellites. Scientists are increasingly able to measure glacier properties over larger areas and longer time spans because of the increased availability of imagery from remote sensing platforms.

Remote sensing yields information about glacier properties including glacier area, length, surface elevation, surface flow fields, accumulation/ablation rates, albedo, equilibrium line altitude (ELA), accumulation area ratio, and the mass balance gradient. Snow and ice are characterized by high reflectivity in the visible wavelengths, medium reflectivity in the near-infrared, low reflectivity and high emissivity in the thermal infrared and low absorption and high scattering in the microwave (Racoviteanu et al., 2008). Increasing amounts of black carbon quickly reduce the albedo of snow and ice. The spatial resolution of a remote sensing image is critical to obtaining glacial properties in mountainous terrain, such as the ELA.

WATER AVAILABILITY IN CHAMOLI

River System

Chamoli District is criss-crossed by several important rivers and their tributaries. Alaknanda River, traversing a distance of 229 kms. before its confluence with Bhagirathi at Devprayag and constituting the Ganga, is the major river. It originates at a height of 3641 meters below Balakun peak, 16 km. upstream of Badrinath, and is formed from the two glaciers - Bhagirath Kharak and Satopanth. The two glaciers rise from the eastern slopes of Chaukhamba (7140 meters) peak, Badrinath peak and its satellite peaks. These peaks separate the Gangotri group of glaciers in the west. The major portion of the Alaknanda basin falls in the Chamoli District. From its source upto Hallang (58 km), the valley is treated as upper Alaknanda valley. The remaining part of the area is known as lower Alanknanda valley. After emanating from its source, the river flows in a narrow deep gorge between the mountain slopes of Alkapuri; from which it drives its name.

Precipitation

Rainfall, spatially, is highly variable depending upon the altitude, refer Table-3. In the Lesser Himalayan Zone (1000-3000m masl) the maximum rainfall occurs in about 70 to 80% of the area in the southern half of the District. August is the rainiest month. The rainfall rapidly decreases after September and it is the least in November. About 55 to 65% of the rainfall occurs in the northern half in the Central Himalayan Zone. About 17% of the annual precipitation occurs in the winter season. The winter precipitation is in association with the passage of the western disturbances and is mostly in the form of snowfall, particularly at higher elevations. The precipitation during the pre-monsoon month, which is about 7% of the annual total and the post-monsoon months, is frequently associated with thunderstorms. Its average normal annual rainfall is 1230.8 mm. The actual rainfall for the year 2003 was 986 mm.

Month	Almora	Bageshwar	Chamoli	Champawat	Dehradun	Pauri-Garhwal	Hardwar	Nainital	Pitheragarh	Rudraprayag	Tehri-Garhwal	US Nagar	Uttarkashi	State average
January	26	32.37	36.17	23.87	27.78	24.6	22.95	21.67	36.97	36.77	30.05	20.43	35.7	28.87
February	24.01	32.3	38.35	22.77	25.02	22.66	19.44	20.04	39.63	38.21	29.37	17.87	37.82	28.27
March	23.47	32.97	38.73	21.34	21.71	21.13	17.24	18.68	42.62	36.75	25.71	16.71	35.29	27.10
April	14.49	23.12	28.28	13.57	13.16	13.08	10.61	10.94	32.77	26.64	16.63	9.37	25.67	18.33
May	35.11	47.36	48.21	36.37	23.56	28.44	20.95	27.86	60.21	45.24	32.11	24.33	39.62	36.11
June	128.56	143.31	129.86	148.18	90.25	104.8	77.89	118.95	149.63	127.76	110.13	107.68	115.24	119.40
July	308.25	317.45	286.85	343.05	268.04	282.4	247.94	296.19	304.07	287.81	289.18	280.38	265.83	290.57
August	313.86	310.05	276.72	332.74	261.6	292.9	262.03	311.08	288.3	275.56	283.85	301.01	251.14	289.29
September	168.53	173.31	153.44	189.63	130.08	150.2	124.05	165.69	168.67	150.48	146.62	159.34	137.28	155.18
October	34.98	42.97	37.1	43.68	17.8	25.74	16.8	33.91	47.95	33.92	24.36	33.36	26.45	32.23
November	4.54	5.83	7.32	3.08	6.68	4.34	5.95	2.8	7.06	7.63	6.61	2.88	9.36	5.70
December	10.05	12.98	13.91	9.29	9.99	9.25	8.15	8.19	16.22	13.77	11.08	7.33	13.4	11.05
Average	90.98	97.83	91.25	98.96	74.64	81.63	69.5	86.33	99.51	90.05	83.81	81.72	82.73	86.84

(From the India Water Portal - Extracted data from the published global CRU 2.1 dataset consisting of interpolated climate grids from the Tyndall Centre for Climate Change Research, Norwich, UK. For details http://indiawaterportal.org/mapguide/MetDist/nonGis1.jsp)

Table-3: Annual Rainfall in different Districts of Uttarakhand (Adapted from: India Water Portal)

Water from glacier melt

A recent study has revealed that Himalayan glaciers are melting twice as fast now as they were before the turn of the century. The figure is double the amount of melting that took place from 1975 to 2000. Scientists have warned that even if the world significantly curbs emissions in the coming decades, more than a third of the world's remaining glaciers would melt before the year 2100. The Himalayan Mountains are the third largest deposits of ice and snow in the world after Antarctica and the Arctic. Stretching over more than 2,000 kms and with 600 billion tonnes of ice, the Himalayan glaciers supply 800 million people with water for irrigation, hydropower and drinking. Glaciers depend on heavy precipitation to replenish ice on an annual basis, but, if the monsoons are disrupted, the ice gets depleted. As the glaciers melt, rivers flood, and with the flooding of rivers, people, crops and livestock get drowned and hydroelectric plants are also disrupted. A weaker monsoon also means less rainfall for the country as a whole that invariably leads to drought and desertification of land.

HYDROPOWER POTENTIAL IN CHAMOLI
HYDROPOWER PROJECTS: CHALLENGES AND ISSUES

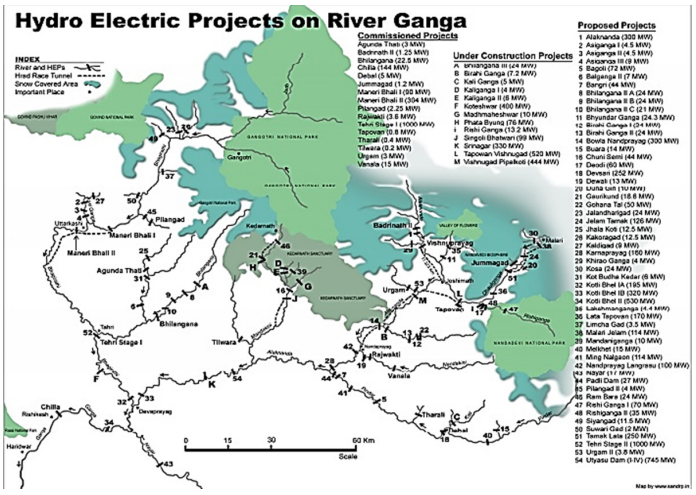


Figure-3: Existing, Ongoing and Future Hydropower Projects in Chamoli (Adapted from: SC order likely to stall only proposed hydel projects in Uttarakhand, Down to Earth)

Environmental, Ecological, Physical and Geological Issues

Overall, hydropower is a cleaner option for energy than non-renewable energy resources such as coal or gas, although in project areas and some adjacent locations, it may have some environmental, ecological and geological impacts. The Hindu Kush Himalaya region is very rich in globally significant biodiversity, and large hydropower development projects may disturb or destroy the habitats of several terrestrial plant and animal species. Studies in the Hindu Kush Himalaya found that deforestation leads not only to diversity loss of forest ecosystems, but also affects the communities depending on forests for their livelihoods. Projects below 25 MW do not require an EIA, Social Impact Assessment, public consultation, environmental clearance, environmental management plan or monitoring. Even for projects above 25 MW credible environmental or social impact assessment are lacking. Figure 3 lists the Hydropower Projects in Chamoli.

The Environment clearances of the River Valley Projects (which includes hydro projects and dams) is considered by the Expert Appraisal Committee on River Valley Projects appointed by the Union Ministry of Environment and Forests, Government of India. However, the members of the EAC seldom object to any project. Environment compliance system is almost non-existing.

One way to achieve compliance is to have a project monitoring committee for each project where over 50% of the members are from local communities and other independent persons and such committees must approve the project at each stage for the project to go progress. More pertinent is that none of the assessment reports look at the impact on the potential of disasters in the area. Each of the projects in this area have a significant impact on the disaster potential, particularly in the context of a vulnerable state like Uttarakhand.

A Disaster Study should be a MUST for all power, infrastructure and other projects in these areas. Environmental Impact Assessments are required only for specific projects of over 25 MW capacity. However, for the river basins of Uttarakhand there is no credible cumulative impact assessment which takes into account the carrying capacity of the river basins and all the interventions that are being done in the basins.

Effect of landslide induced sediment load on hydropower projects

Landslide is generally understood as being a downslope movement of rock mass, debris, soil and earth, with or without water, under the influence of gravity. It includes both consolidated and unconsolidated material originating from a variety of geomorphic features due to natural and manmade causes. The definition makes it clear that physical features is a precondition for an area to be affected by landslides and it is physical features that is a must for identifying any area as being mountainous. Sedimentation affects the safety of dams and reduces energy production, storage, discharge capacity and flood attenuation capabilities. It increases loads on the dam and gates, damages mechanical equipment and creates a wide range of environmental impacts. Land sliding is an important landform building process that promotes soil formation.

Most habitations in the hills are situated on stabilized old landslides and terraces formed over deposits of river borne materials. With increasing population pressure and switch over to comfort preferring life style people increasingly prefer to settle down on these materials itself that in many cases are close to the road head and the streams. Once instability is introduced in a hill slope it often becomes chronic and slope instability repeatedly take place at the same place.

Reservoir sedimentation is a process of erosion, entrainment, transportation, deposition and compaction of sediment carried into reservoirs formed and contained by dams. In unregulated, mature rivers with stable catchments, sediment processes are relatively balanced. Construction of a dam decreases flow velocities, initiating or accelerating sedimentation, resulting in progressively finer materials being deposited.

There are three stages in a reservoir's life:

a) Continuous and rapidly occurring sediment accumulation,

b) Partial sediment balance, where often fine sediments reach a balance but coarse sediments continue to accumulate, and

c) Full sediment balance, with sediment inflow and outflow equal for all particle sizes.

Most of the world's reservoirs are in the continuous accumulation stage. Many were designed by estimating sedimentation rates in order to provide a pool with sufficient volume to achieve a specified design life. However, this design life is typically far less than what is actually achievable. Therefore, managing reservoirs to achieve a full sediment balance is essential in order to maximize their lives. Developing regions of the world that stand to benefit most from hydroelectricity are often those with the highest sediment yields. Hence, in these regions, sustainable hydropower development must involve consideration of sediment management techniques during design, construction and operation.

Sediments effect on generation

About 0.5% to 1% of the total volume of 6,800 km3 of water stored in reservoirs around the world is lost annually as a result of sedimentation. Consequently, the global per capita reservoir storage has rapidly decreased since its peak in around 1980. The current storage is equivalent to levels that existed nearly 60 years ago. Loss of reservoir storage reduces flexibility in generation and affects the reliability of water supply.

Sediments impact on stability

Sediment loads are commonly idealized as a static at-rest soil pressure. The U.S. Bureau of Reclamation's Design Manual for Small Dams suggests that sediments be considered equivalent to a fluid with an implied pressure coefficient of about 0.39 and an internal friction coefficient of about 37 degrees. However, actual reservoir sediment properties can vary considerably. Unconsolidated fine-grained sediments likely have lower shear resistance and a higher at-rest pressure coefficient, while a reservoir filled with coarser sediments may have a higher shear strength.

Sediment impacts on discharge capability

Sediments often block low-level outlets designed to allow for reservoir drawdown. As sedimentation continues, clogging of spillway tunnels or other conduits may occur. Reduction of spillway capacity can occur as a result of the loss of approach depth when the sediment front reaches the dam. The reservoir becomes a delta-filled valley that takes a meandering course such that a flood wave does not spread out to allow flood routing.

Sediments impact on equipment

Sediment can damage turbines and other mechanical equipment through erosion of the oxide coating on the blades, leading to surface irregularities and more serious material damage. Sustained erosion can lead to extended shutdown time for maintenance or replacement. Materials used commonly in sediment-prone hydropower plants are stainless steels that are heat treated for hardening and increased protection from abrasion. Protecting mechanical equipment from sediment abrasion can also be achieved with hard surface coatings of ceramic paints or pastes or with hard facing alloys. Research has shown improved resistance to sediment abrasion when tungsten carbide-based composites are used as a surface coating.

Effect of Glacial Lake Outburst Flood (GLOF) on hydropower projects

Glacial Lake Outburst Floods (GLOFs) in particular are a well-publicized, though insufficiently quantified, hazard to HPP (Sharma and Awal 2013, Vaidya 2013, Molden et al 2014, Reynolds 2014). Large amounts of meltwater from Himalayan glaciers are impounded as lakes behind moraine dams. Dozens of these natural debris dams have failed catastrophically in the 20th century, releasing destructive flash floods and debris flows. In 1985, a proglacial lake of Langmoche Glacier, Khumbu Himal, Nepal, emptied rapidly, generating a flood wave with a peak discharge Qp of ~2000 m3/s, and sluicing 3 × 106 m3 of sediment that obliterated a nearly completed HPP, along with nine years of negotiations, planning, and construction (Ives 1986). Torrential rains rapidly raised the water level of the moraine-dammed Chorabari Lake, Uttarakhand, India, in June 2013. The dam breached and released 400 000 m3 of water into the already flooded Mandakini River, inundating the pilgrimage city of Kedarnath (Allen et al 2015), and severely damaging at least two HPP sites downstream (Sandrp 2013).

The recognition that GLOFs can substantially exceed design floods of HPP at the risk of damage or complete inoperability (Richardson and Reynolds 2000) hinges on a handful of case studies, but the regional picture of GLOF exposure remains ill-defined. Most previous efforts to identify future GLOF sources from lake inventories disregard downstream impacts (Strozzi et al 2012, Fujita et al 2013). Hydrodynamic modeling of such impacts requires detailed digital elevation models (DEMs), and substantial computing power, so that simulations of potential outbursts are available for only a handful of lakes (Worni et al 2013). We fill this research gap by combining a new glacial lake inventory (figure 1) with both a dam-breach (Walder and O'Connor 1997) and a flood-propagation model (Ponce et al 2003) to estimate potential flood magnitudes for a sample of operating, planned, and currently constructed HPP in the Himalayas. It can be explained with the help of Figure-4.

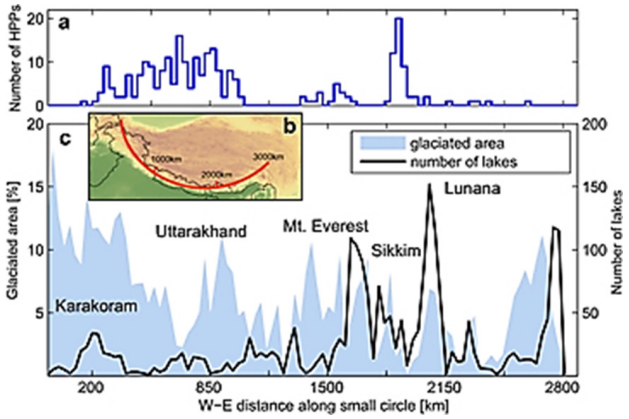


Figure-4: Distribution of Himalayan hydropower projects, glaciers, and glacial lakes. (a) distribution of HPP sampled in this study along a small circle fitted to the axis of the Himalayan arc (inset (b). (c) percentage of glaciated area above 1900 masl, and number of glacial lakes. (Adapted from: Uncertainty in the Himalayan energy–water nexus: estimating regional exposure to glacial lake outburst floods by Wolfgang Schwanghart, Raphael Worni, Christian Huggel, Markus Stoffel and Oliver Korup)

Estimated peak discharges at potential breach sites vary by two orders of magnitude for a given lake area, and mainly reflect uncertainties about lake bathymetry, breach depth, and breach rate. For smaller lake areas, lake depth and lake volume produce most of the spread in Q0. For larger lake areas, breach depth and rate contribute most of this uncertainty. GLOF waves attenuate rapidly downstream, whereas meteorological flood peaks grow with increasing drainage area (Cenderelli and Wohl 2001, Koike and Takenaka 2012). Thus, 'impact reaches' dc, is defined as the modeled GLOF peak discharge which exceeds the estimated 100-year meteorological flood. Such impact reaches occupy the upper ~20 (+35/−13) km (90% bootstrap confidence interval) below half of all lakes mapped. Only the Estimated peak discharges at potential breach sites vary by two orders of magnitude for a given lake area, and mainly reflect uncertainties about lake bathymetry, breach depth, and breach rate. For smaller lake areas, lake depth and lake volume produce most of the spread in Q0. For larger lake areas, breach depth and rate contribute most of this uncertainty. GLOF waves attenuate rapidly downstream, whereas meteorological flood peaks grow with increasing drainage area (Cenderelli and Wohl 2001, Koike and Takenaka 2012). Thus, 'impact reaches' dc, is defined as the modeled GLOF peak discharge which exceeds the estimated 100-year meteorological flood. Such impact reaches occupy the upper ~20 (+35/−13) km (90% bootstrap confidence interval) below half of all lakes mapped. Only the farthest-reaching GLOFs may surpass the estimated 100-year floods for up to 85 (+45/−65) km downstream. Sikkim, particularly stands out as a region combining

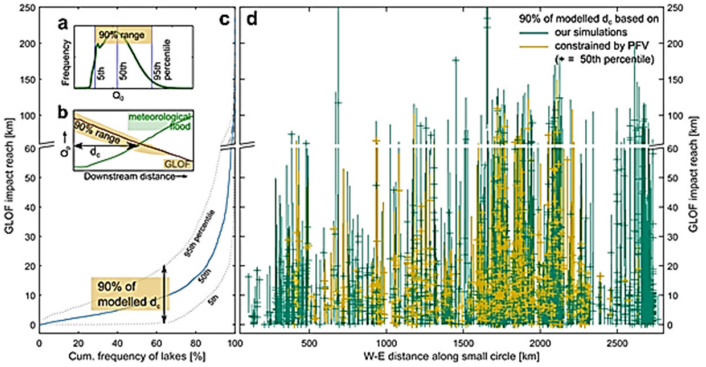


Figure-5: Distribution of GLOF impact reaches: GLOF impact reach dc refers to those channel segments where simulated GLOF peak discharges exceed local meteorological 1-in-a-100-year flood peaks below a given glacial lake. Uncertainties about dc derive from distributions of simulated peak discharge at the breach sites (a), and flood-attenuation modelling (b).
(a) exemplary distribution of peak discharge q0 simulated at the breach site of a sample lake; percentiles are used as input to the flood-propagation model.
(b) sketch of differing downstream trends in GLOF and meteorological flood peaks.
(c) simulated distribution of dc. More than half of all potential GLOFs exceed 100-year meteorological floods at <20 km downstream from the lakes; only 1% of the lakes could theoretically release GLOFs with impact reaches of 85 km (+45/–65 km; 90% bootstrap confidence interval).
(d) distribution of GLOF impact reaches along the Himalayan arc.
(Adapted from: Uncertainty in the Himalayan energy–water nexus: estimating regional exposure to glacial lake outburst floods by Wolfgang Schwanghart, Raphael Worni, Christian Huggel, Markus Stoffel and Oliver Korup)

abundant glacial lakes, long potential GLOF tracks, and pronounced hydropower development. Several regions in Eastern Nepal and Bhutan also host lakes that could give rise to far-reaching GLOFs. It can be explained with the help of Figure-5.

The distance from glacial lakes is another decisive factor in hydropower projects exposure, and modulates the spread in simulated GLOF peak discharges at a given site. The spread becomes narrower downstream irrespective of the initial value at the breached dam (Ponce et al 2003). For hydropower projects which are at an adequate distance from glacial lakes, the uncertainty regarding Qp thus decreases. To identify the river reaches with the highest uncertainties, the distance at which the 90% bootstrap confidence interval of our modeled Qp narrows to <5% of that at the dam site was determined. In more than half of all cases that distance was 80 km (+100/−60) km. Steep headwater channels stretching a few tens of kilometers below glacial lakes rarely dampen peak discharges (Ponce et al 2003), and are thus prone to more variable GLOF peaks. Next it was required to compute, for the hydropower projects planned or currently constructed in the headwaters, which may have to deal with an uncertainty about Qp that is more than twice than that in the downstream reaches due to existing hydropower projects which were in already operation. The Downstream trend of uncertainties in GLOF simulations is shown in Figure-6.

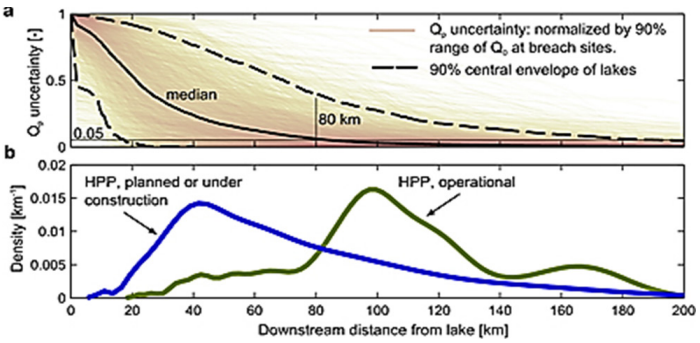


Figure-6: Downstream trend of uncertainties in GLOF simulations.
(a) uncertainty about local peak discharge Qp expressed as the 90% range of simulated values normalized to peak discharge q0 at the breach site. The uncertainty decreases downstream at different rates. For 90% of all lakes, the range of normalized Qp reduces by 2% to 90% along the first 20 km downstream of the lakes; such uncertainties decay to <5%> 80 km downstream.
(b) distribution of distances of HPP sites from glacial lakes.
The currently planned or constructed HPP projects are in river sections with higher uncertainty (a) as compared to operational HPP.
(Adapted from: Uncertainty in the Himalayan energy–water nexus: estimating regional exposure to glacial lake outburst floods by Wolfgang Schwanghart, Raphael Worni, Christian Huggel, Markus Stoffel and Oliver Korup)

Effect of glacial breaks/ avalanches on hydropower projects

The effect is that a large number of access roads to the plants and construction sites get damaged and that leads to structural damage of the hydropower plant, depending on the flow velocity of the floodwaters. There could also be operational problems which otherwise would not have been considered in the design. Those are linked to losses in turbine time efficiency, caused by dragging of solids in the water. Cleaning operations using desanders and settling basins have to be increased. Due to the increase in the dissolved solids in the water, the settling tank and filtration facilities could collapse after some time.

Effect of catchment area erosion due to seismic activity on hydropower projects

Sediment can be entrained by scouring unconsolidated deposits of the channel bed, or eroding landslide and collapse of lateral slopes. In the seismic belts, a large number of weak soil structures and broken rocks develop along the active fracture zone, and the soils become looser after an earthquake.

Studies showed that large earthquakes, such as the Chi-chi earthquake and Wenchuan earthquake, triggered many collapses and landslides, resulting in an increase in loose deposits. Although rare, the reported GLOF events in the Himalaya are directly triggered by earthquakes, the loose deposits and landslides induced by earthquakes may affect the magnitude and impact of GLOF. Therefore, it is necessary to build a GLOF hazard assessment model, considering small glacial lakes and the scenario of glacial lake outburst debris flows after earthquakes, especially in areas where many collapses and landslides have developed along the channels.

REVIEW OF RECENT DISASTERS IN UTTARAKHAND

2013 floods in Kedarnath

According to the Wadia Institute for Himalayan Geology and other scientific agencies, the disaster was caused firstly by the early arrival of the annual monsoon that accelerated snow melting, occurrence of higher than normal rainfall, and then a cloudburst that dumped at least 300 millimeters (12 inches) of rain on June 16th 2013 on the Himalayan ridges that fed the Alaknanda and the Bhagirathi River basins.

The second event, a direct result of the cloudburst, was the collapse of the banks that retained the waters of Chorabari Lake, a glacial lake fed by rain and snowmelt that was located at 3,960 meters (13,000 feet) and two kilometers (1.2 miles) upsteam of Kedarnath, in the Mandakini River floodplain. Chorabari Lake, 400 meters long by 200 meters wide and up to 20 meters deep (1,300 feet long, 660 feet wide and 60 feet deep) released all of its water in 10 minutes.

The floodwaters poured down the steep valleys, flowed out of the river channels, and lashed at everything in their path. Kedarnath, Rambara, Gaurikund, much of Sonprayag, and other villages disappeared under the deluge of the water, boulders and mud. The rivers clawed at the banks and bluffs, causing over 100 landslides that brought down or damaged more than 1,000 kilometers of highways and caused an unknown number of hotels, homes, shops, and government buildings to fall into the torrent. A joint study by The World Bank and the Asian Development Bank estimated that the damage to public infrastructure - roads, water transport, buildings - amounted to nearly $700 million.

Destruction due to floods

The 520-megawatt Tapovan-Vishnugad dam, under construction on a tributary of the Alaknanda River was seriously damaged in by a flash flood, was hit again in 2013. The tunnel carrying water to the powerhouse, finished in April 2013, was washed away in June. Just upstream of this was the 171-megawatt Lata Tapovan project, under construction and scheduled for opening in 2017, was overrun by the floodwaters that damaged concrete work and forced at least a year-long delay in its commissioning. The delay could grow longer because the highway network was so broken and unstable that it was unsafe to transport heavy equipment that was needed for repairs. Both of the Maneri Bhali projects on the Bhagirathi River were also damaged. The 25-year-old Maneri I dam, with a 99-megwatt generating capacity, and the 304-megawatt dam that opened in 2008, were hit so hard that the walls collapsed. Heavy rains also affected the dams in the other regions of Uttarakhand including the Banbasa project on the Sarda River in eastern Uttarakhand near Nepal.

Review of 2021 Chamoli floods

Disaster struck Uttarakhand's Chamoli District on 7th February 2021, when a massive flash flood ravaged through the valleys of the Rishi Ganga, Dhauliganga and Alaknanda rivers. More than 70 people were confirmed as dead and another 134 people were reported missing. Satellite images of the area are shown in Figure-7. The flood swept away the unfinished Tapovan Vishnugad Hydropower Project and inflicted substantial damage on the Rishi Ganga Hydropower Project (Refer to Figure- 8).

Figure-7: These Copernicus Sentinel-2 images show the aftermath of the Chamoli disaster on February 7, 2021. The dotted orange line in the right image shows the site of the collapse from the north slope of the Ronti peak. (Left: 2016, Right: Feb 7, 2021). (Abstracted from: Chamoli disaster: Unnoticed slope movement that began in 2016 and led to Himalayan tragedy in 2021, India Today)

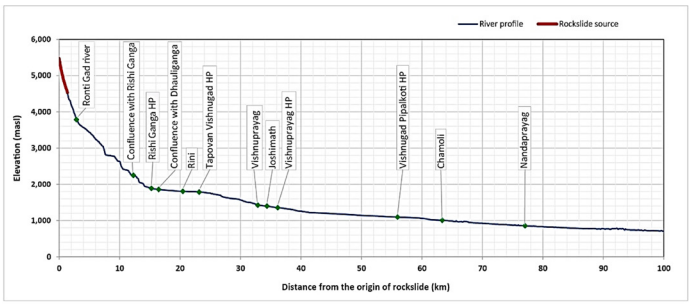


Figure-8: Elevation vs The distance from the origin of rockslide in Chamoli (Adapted from: Understanding the Chamoli flood: Cause, process, impacts and context of rapid infrastructure development, ICIMOD)

After examining the pre and post-event imagery it was found that a crack had formed prior to the event at the site where the rock detachment followed by a rockslide occurred. That failure eventually propagated along a 550 m wide crest starting at an elevation of 5500 masl and reaching down to nearly 4500 masl. Analysis of elevation models pre and post-event suggested that the scarp left by the rockslide was 150 m deep; 100 m on average and consisted largely of rock and relatively little ice. It was 39° steep, 1060 m long and covered an area of ~350,000 m2. That resulted in an approximate volume of 22 mio m3, which corresponds well with the DEM differencing (DEM differencing is the most appropriate change detection method.) that puts it at 25 mio m3. Relying on modelled glacier thickness (21 to 25 m for the three glacierettes in the inventory, which correspond to typical heights of such hanging glaciers; Farinotti et al. 2019), it can be estimated that the fraction of rock would have been 85% and ice 15% and the calculated total mass would have been ~52 * 109 kg.

Reasons for occurrence of rockslide

A. Precedent weather conditions

A strong western disturbance passed across Kashmir and northwest India from 4th to 6th February 2021. It was fully charged with convective instability that may have contributed to the heavy precipitation. The unfortunate disaster event occurred on 7th February 2021.

B. Climate change

Maximum temperature in the Chamoli area has increased at the rate of 0.032 oC per year between 1980 and 2018 which is statistically significant at 99.9% confidence level, compared to minimum temperature which has increased at 0.024 oC per year at 90% confidence level. The trends were analyzed using Mann–Kendall (MK) and Sen slope estimation (Kendall 1975; Mann 1945; Sen 1968). Furthermore, January 2021 was the warmest January on record in Uttarakhand for six decades. The maximum and minimum temperature trends in Chamoli area have been mentioned in Figure- 9.

C. Other factors

At the same headwall (from the elevation of 5500 masl to 4500 masl), a large ice avalanche had been previously released somewhere between 19th September and 9th October 2016, which had deposited ~1.5 * 107 m3 of ice and more bedrock in the valley below.

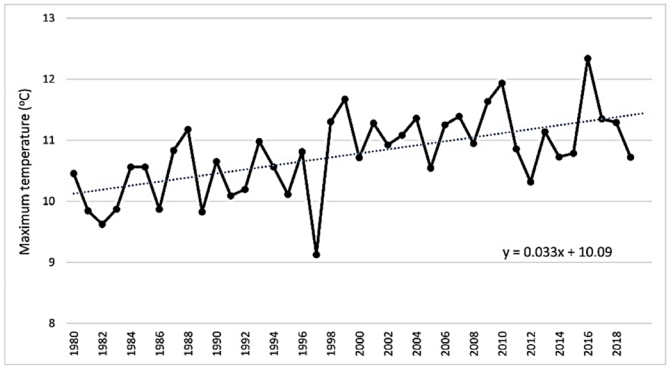


Figure-9: Maximum temperature trends in the Chamoli area (Data source: era5 reanalysis data, 1980-2019)

The resulting destabilization of the rock due to the lack of ice cover (glacial debuttressing, stress-release fracturing), and increased exposure to solar radiation and hence an increased freeze thaw cycle, in combination with a large snowfall event preceding the event of 7th February 2021 and the rapid melt water that got generated, may have favoured the fracturing of rock.

CONCLUSIONS

The paper highlights the importance of considering the factors, brought about by climate change, into the design of new hydropower projects in the Himalayan region, besides building resilience by retrofitting the existing projects and operating the plants not on historical records but rather on real time data basis. To prevent future climate change related impacts arising out of GLOF, Avalanches, Landslides, etc. an advanced IoT based monitoring systems on real time basis is necessary and essential to prevent calamities.

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Urban Flood Mitigation - Bengaluru A Case Study

Y.D Manmohan
Jt. Vice President
Group Head – Environmental and Public Health Engineering
Assystem STUP, Bengaluru

Introduction

Urbanisation of Bengaluru, like any other Indian cities is leading to more and more flooding issues due to change in land use, encroachment of water ways and water bodies. The flooding problem is compounded by increased short duration higher intensity rainfall due to climate change. Bengaluru Mahanagara Palike's area of 790 sq.km has a stormwater drainage network of around 840 km length of Primary and Secondary drainage systems as shown in Figure-1. The Secondary valleys are the one which receive storm water from the street drain network and draining that into the Primary Valley/Drain and which are the ones convey the storm water into a lake/ river system.

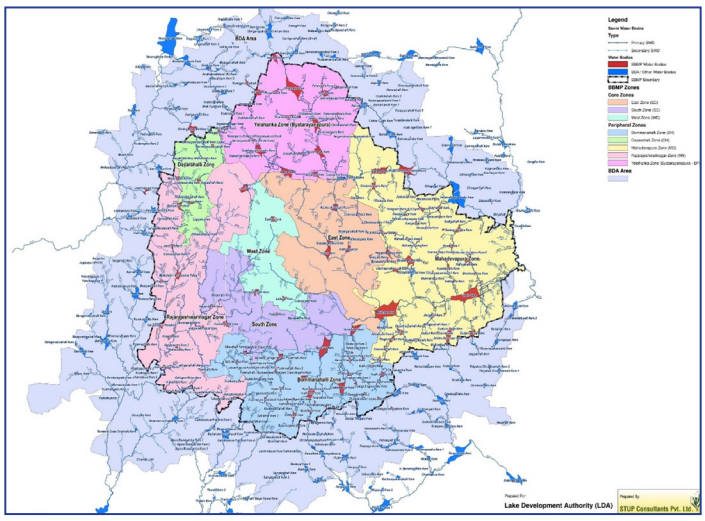


Figure-1: Map Showing lakes and drainage networks in Bengaluru

Key problems associated with the Bangalore Drainage system are:

The drainage system has been encroached at many places and that is leading to frequent flooding. In this paper the terms 'drain' and 'drainage' invariably refers to "stormwater drain' and 'stormwater drainage'.

1. Prior to development of urban areas, the original storm water drainage system capacity was planned for land use which was mostly open land and were thus sufficient to carry the runoff after infiltration in open area and filling of the lakes. However, in the recent past due to urbanization and changed land use, the run off has increased considerably making the original drain/ valley size insufficient to carry the flood discharge.

2. For the present land use, many drains do not have the capacity to carry even one year highest intensity rainfall, which thus resulting in frequent flooding. A few photos of flooded areas are shown in Photos-1 to 6 where the capacity of the storm water drains were inadequate.

3. In addition to the limited capacity of the storm water drain/ valley, there is a considerable quantity of sewage flow in the drain as shown in Photo-7 which should have been collected and carried separately in municipal sewer pipes.

4. Due to ineffective garbage management system, garbage finds its way into the storm water drainage system resulting in chocking of the drainage system as shown in Photo-8.

5. Due to rapid urbanization and construction/ demolition activities, lot of debris and construction materials are also finding their way into the storm water drains as shown in Photo-9 which cause obstruction to the free flow of stormwater.

Photos-1 to 6: Flooding problem

Photo-7: Sewage in storm water drain

Photos-8 & 9: Garbage and construction waste dumping in storm drains

6. A lot of building construction materials like sand, soil, even aggregates and brick bats/ crushing, etc. gets washed into the drain during rain causing severe silting of the storm water drains year after year causing reduction in drain capacity as shown in Photo-10. To minimize flooding,

Photos-10: Silt accumulation in storm water drain

City Corporation is incurring a huge expenditure on desilting of storm water drains and also facing disposal of silt problem.

7. The drain/ valley sizes are further restricted by a lot of utility services like manhole/ pipes, electric & communication cables, etc., at the vent of culverts as shown in Photos-11 & 12 and also cause frequent flooding.

Photos-11 & 12: Utility services in storm water drains obstructing flow

8. Due to sewage flow in the drains, in most of the places, the drain connectivity to lakes have been removed to prevent sewage stagnation in lakes as shown in Photos 13 & 14 which otherwise would have acted as flood holding system.

Flood Mitigation Measures

Photos 13 & 14: Sewage entry to lakes

Due to dense developments, procuring of additional land to increase the drain width is near to impossible. Hence, some flood mitigation measures which are being implemented by Government of Karnataka are discussed hereunder.

Even though, the drains have been designed for two year flood return period (Flooding once in two years), other issues like sewage flow into the drain, debris and other solid wastes getting into the drain, restricted culvert vents need to be tackled along with the implementation of remodelled drains.

To reduce frequency of flooding with the available remodelled drain cross section, the following needs to be done.

• Reduce the runoff at source by implementing rain water harvesting at individual plots, create more pervious surface, use pond and lakes as flood holding ponds. If the rain water holding tank is sized to hold the peak intensity of rainfall for a period of 0.5 to 1 hour for Bengaluru based on the study of past rainfall data, considerable load on the municipal drainage would get reduced. Figure-2 explains the two scenarios. The one on the left side of the diagram is without rain water harvesting resulting in high runoff requiring higher drain capacity and on the right side of the diagram is the one with rain water harvesting which shows a subdued peak with lesser discharge.

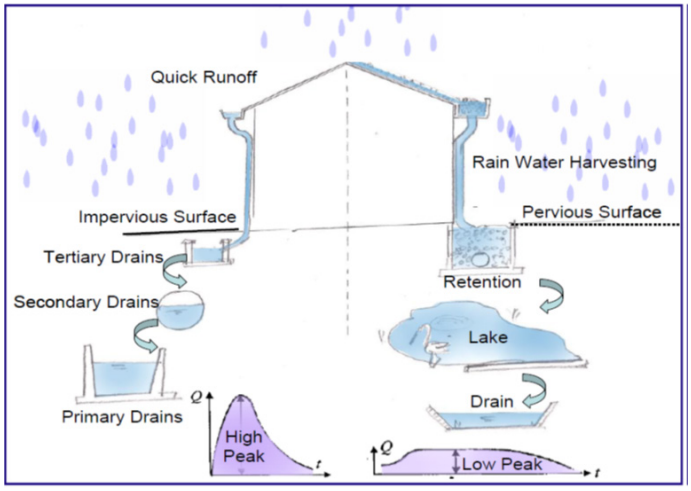


Figure-2: Runoff with and without Rain Water Harvesting

• Remodel the drainage network to improve the carrying capacity. Provide recharge pits at regular intervals in the bed of RCC drains as shown in Figure-3 which would recharge the ground water and reduce discharge to some extent.

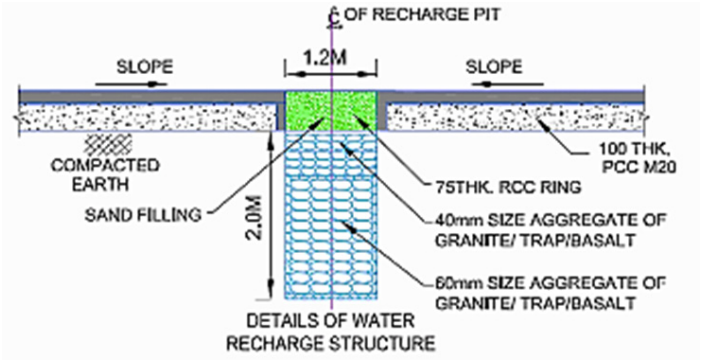


Figure-3: Recharge Structures

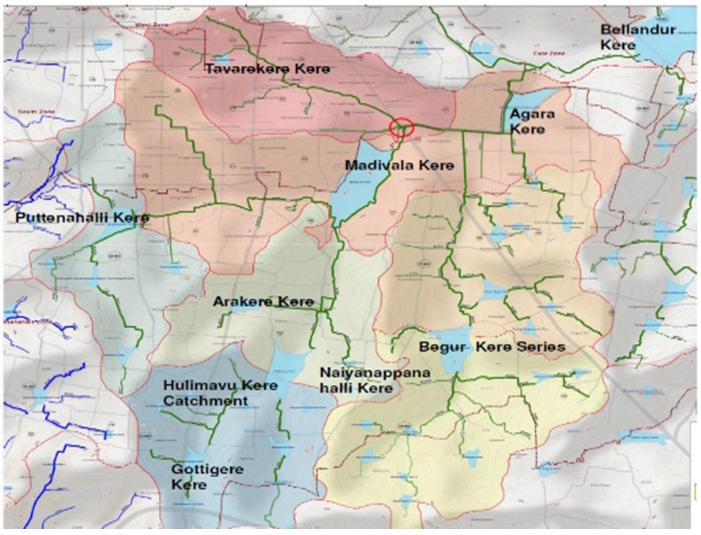


Figure-4: Storm Drain connectivity to lakes

• Lakes need to be rejuvenated with connectivity of the drainage system for free flow of storm water as well as for flood holding. In Bengaluru many lakes are getting rejuvenated and drainage connectivity is getting established as shown in Figure-4. Photos -15 &16 show a lake before and after rejuvenation along with interlinking of lakes.

Photos-15 & 16: Mallathalli Lake before and after rejuvenation

• Lake management with flood control gates would avert flooding of downstream areas. The discharge of flood water to the downstream drain could be controlled within the drain capacity. The major lakes upstream and downstream areas which are affected frequently by flooding should have gate control arrangement to release the water from the lake before the rain so that the lake then has the capacity to receive the flood water as shown in Figure-5. Provide flood warning system with level sensors in gate controlled lakes.

• While remodelling the drains, intercepting sewers on either side of the drain could prevent sewage getting into the drain. By doing so, the drains and the connected lakes would be free of sewage and would be available to carry more flood discharges. A sample drawing of drain with intercepting sewer is shown in Figure-6

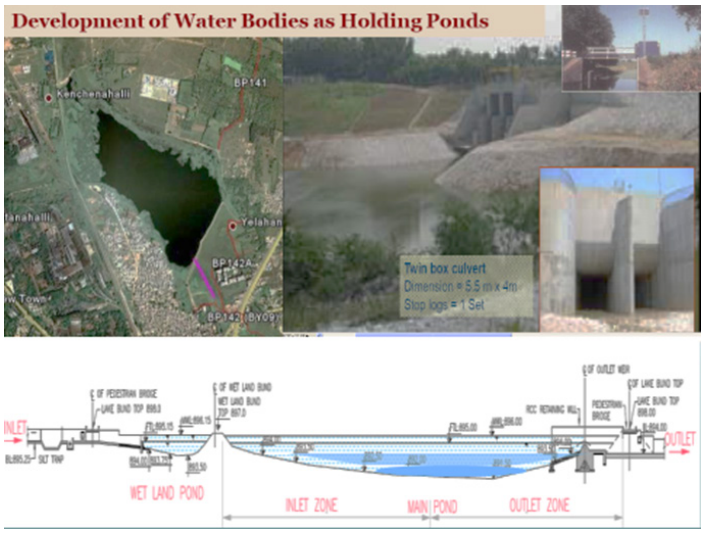


Figure-5: Flood control gate arrangement for lake

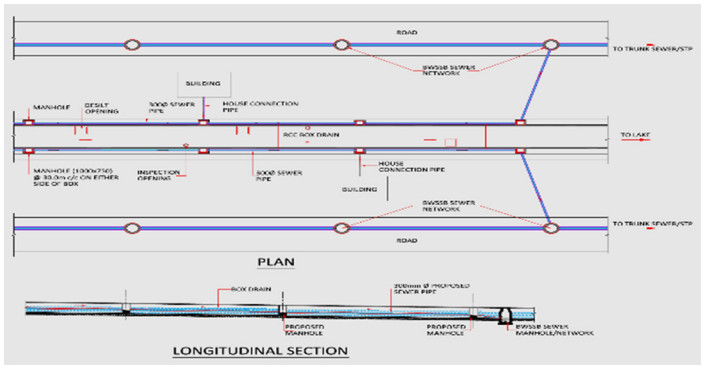


Figure-6: Intercepting sewers on either sides of storm water drain

Development of flood holding ponds in open parks and playground in low lying areas. To minimize the flooding problems in low lying areas or those that get frequently flooded, runoff entering from higher catchment should be diverted to the detention/ holding pond created in the low lying area, which could be in parks or play ground with roadside drain network connectivity to it from the entire low lying area. A mobile pumping station should be provided as shown in Photo-17 to pump out the water from the holding pond after the rain fall and keeping the pond ready to receive the next flood.

Photo-17: Mobile Pumps

• Remodel the culverts having restricted vent way as shown in Photo -18 to increase the cross sectional area and improve the carrying capacity.

Photo-18: Restricted vent way

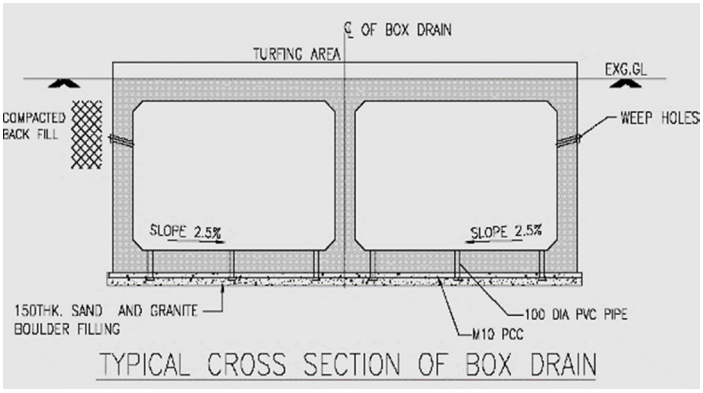
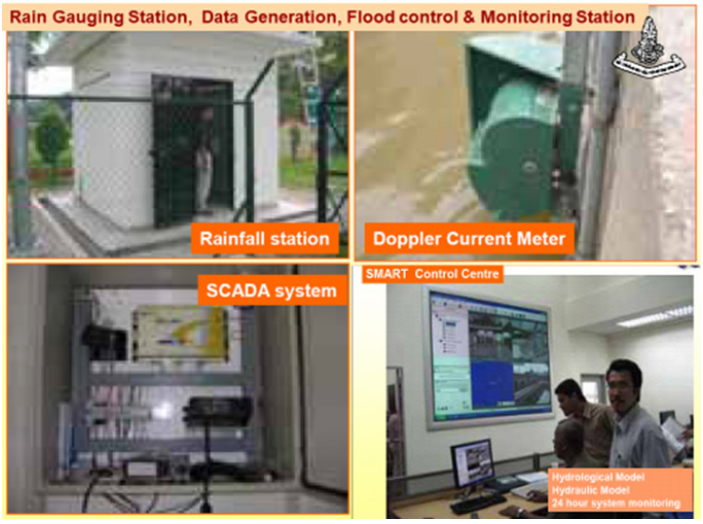


Figure-7: Typical Cross-Section of Box Drain

Most of the pipe culverts are remodelled with box culvert as shown in the Figure-7 which minimised the flooding problems in the area to a great extent.



Photos-19 to 22: Rain Gauging Station, Data Generation, Flood Control & Monitoring Station

• Provide water level sensors and alarm system in flood prone area drains to monitor the flood water flow and take damage control measures. Some remodelled drains in Bengaluru have been provided with level and flow sensors which are connected to the Flood monitoring and Warning System shown in Photos-19 to 22.

Conclusions

By implementing the above recommendations, flooding could be minimised to a great extent as has been experienced in Bengaluru.

In addition to reduction in flooding incidences, the additional advantages are:

- Maximizing the flood return period
- Sewage free drains and lakes
- Opportunity for tapping additional water source from the rejuvenated lakes and water bodies
- Enhanced environment and quality of life.

Acknowledgements

The author gratefully STUP Consultants Pvt Ltd (now Assystem STUP) clearance for the paper to be written and Bruhat Bengaluru Mahanagara Palike (BBMP), the Project Authority for consenting to share the project data for this paper.

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STUP Consultants (now Assystem STUP)

The Water Division in STUP Consultants has been engaged in projects dealing with Urban Drainage, Urban Lake Rejuvenation projects, Urban and Rural Drinking Water Supply projects, Sewerage and Sewage Treatment projects for urban areas, Waste Water Recycling plants for reuse of water, Complete Water Cycle project for sustainability involving rain water harvesting and tertiary treatment of sewage for Airports, large Industrial and Business parks.

Modelling Catchment-Scale Rainwater Harnessing as aRoadmap to Achieve Bengaluru's Water-Secured Future

Gaurav Bhatt
Senior Project Manager – Water Resources

Dr. Vivekanand Honnungar
Senior Engineer – Water
Jacobs Engineering Group, Bengaluru, India

Vinod Singh
Director – Digital and Water, Asia
Jacobs Engineering Group, Singapore

KEYWORDS : Harnessing rainwater on catchment scale; sustainable, resilient and circular urban water management; water reuse

ABSTRACT

Bengaluru, the Capital of the State of Karnataka, India, is known as the 'City of Gardens' and is also the 'IT Capital of India'. Bengaluru's early history relied on a network of streams and lakes for supply and amenity which have since become polluted and neglected. Bangalore Water Supply and Sewerage Board (BWSSB), is the water utility responsible for providing water services for the city of Bengaluru, whose population was more than 11 million population as of 2020 in an area of 800 km2. The solution proposed was to diversify Bengaluru's water portfolio by including harnessed rainwater as a local and sustainable water source. The primary purpose and key objective of the project was to investigate and determine the technical feasibility and identify the potential financial, environmental and social benefits of capturing, treating and supplying urban rainwater/stormwater for potable and non-potable purposes, and groundwater replenishment. The solutions developed for the project were contextual, incorporating technologies, innovations and good practices in collection, conveyance and treatment of stormwater, as well as in lake ecology sciences. Continuous stakeholder engagement and public outreach was a key component of the project. The urban build form was considered to integrate the rainwater/stormwater into the living urban fabric of Bengaluru and help increase the liveability of the city while meeting people's growing aspirations for improved urban spaces.
The solution envisaged restoring lakes and creating them as a focal point for local citizens and community wellbeing. BWSSB's blueprint for future-proofing its water supply needs were recognised at the 2018 Global Water Awards.

INTRODUCTION

Bengaluru, the third most populous city in India (approximately 11 million people as of 2020), with population growth of around 50% over the last three decades, has a total water demand of 1,800 MLD (against a supply of 1,300 MLD). It is estimated that the water shortfall of approximately 500 MLD is met by groundwater extraction. Consequently, in some areas of Bengaluru, the groundwater table has gone more than 300m (1,000 feet) deep.

River Cauvery, the primary source of water for Bengaluru is located approximately 100 km south of the city and 450 m below the city's elevation. BWSSB spends approximately 70% of its operational budget in treating, pumping, and distributing the drinking water to the city. Rapidly increasing water demand, coupled with interstate water sharing conflicts, are placing Bengaluru in an increasingly water vulnerable situation. It is estimated that by 2050, BWSSB would be serving over 20 million customers, around twice as many as of today, and a water demand of approximately 4,000 MLD.

In recognition of this situation, BWSSB is actively considering the viability of identifying additional water resources, which can be utilised to bridge the projected water demand and supply gap. Harnessed rainwater at catchment scale presents itself as a potentially sustainable water source for the city.

The project comprised investigation of the potential for harnessing

rainwater from urban catchments[1] of Hebbal Valley and part of Vrishabhavathi Valley (V Valley) and develop it as a future water supply source. With a study area of approximately 300 sq.km., project vision was to collect, store, treat and reliably distribute rainwater by using lakes for water storage. The current population within the study area is 2.9 million with a water demand of 468 MLD. The current piped water supply in the study area is around 300 MLD and the groundwater extraction is approximately 100 MLD. There are 45 lakes in the study catchment with an area of 2 hectare or more, which were studied under this project. Out of these lakes, around 10 lakes are perennial, and the remaining lakes stay filled for around 9 months in a year. Water stored in these lakes is used for cattle and for fishing. Based on the size and feasibility for utilising the lakes to store rainwater, 9 lakes were considered (refer Table-1), which contains 90% of the total storage volume available in the study area.

Table-1: Lakes considered as storage

Lake	Surface Area (Ha)	Maximum available storage Volume (ML)
Dasarahalli Lake	7	397
Hebbal Lake	48	2,582
Jakkur Lake	48	2,582
Kalkere Lake	55	2,012
Madhavara Lake	25	1,671
Rachenahalli Lake	42	3,211
Rampura Lake	78	3,203
Yelahanka Lake	105	5,273
Yellamallappa Chetty Lake	206	9,447
Total Storage volume		**30, 378**

Remaining lakes were considered to be developed as part of local biota enhancement and groundwater recharge.

The scope also included the development of a stakeholder and public education, outreach and engagement program focusing on important initiatives for developing a participatory approach with various stakeholders. The program stressed on the importance of using rainwater/ stormwater as a potential water source for Bengaluru, and therefore the need to protect it. Such preliminary stakeholder groundwork is essential for the future success of rainwater projects.

The objective of identifying the volume of rainwater available to harness was achieved by reviewing the existing study area for hydrology and hydraulics, stormwater generation potential, available storage and then deriving the cost-effective project outcome.

STUDY AREA

The rainwater harnessing catchment area is approximately 300 sq.km and is located on the northern side of Bengaluru. The area is primarily urban, with small areas of agricultural land and other open ground. The key features of the study area are presented in Table-2. Overall, the study area contains approximately 59 Lakes that are larger than 1 Ha. There are 45 lakes identified within the hydrological catchment area that are larger than 2 Ha. Figure-1 shows the lakes within the study area.

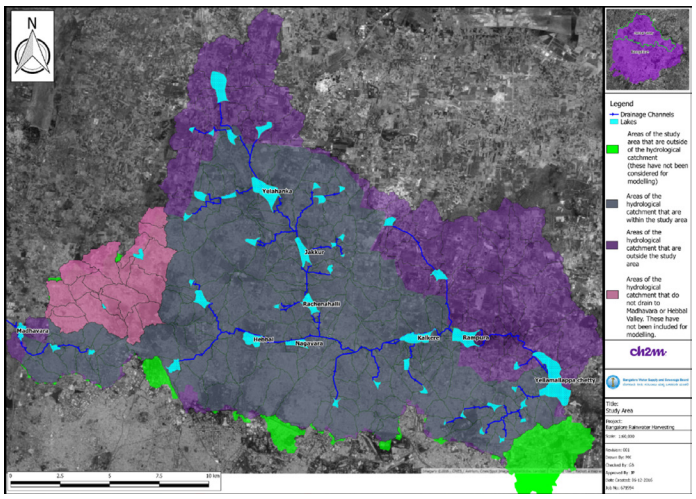

Figure-1: Map showing 45 lakes within the hydrological boundary

Feature	Value
Catchment study area	300 sq.km
Number of lakes with area > 2 ha	~ 45
Available storage volumes in lakes	34, 000 ML
Population	2.1 million
Water Demand	162 lpcd (litre per capita per day)
Used water generation	130 lpcd
Water Reclamation Plants	6
Average annual rainfall	957 mm
Predominant soil types	Clay, loamy clay
Drainage channel length	54 km
Standard of drainage	Poorly maintained. Low standard of flood protection. Prone to blockage.
Condition of lakes	Partially remediated but with significant water quality and maintenance issues due to direct used water ingress

Table-2: Key Features of Study Area

APPROACH

Vision for this project was to collect, treat and distribute rainwater while preserving and bettering Bengaluru's natural ecosystem in the study area. Figure-2 outlines the overall process of collecting, treating and distributing rainwater as a reliable and sustainable water source for drinking and non-drinking purposes.

There were several practical challenges while developing solutions to harness rainwater at the catchment level in Bengaluru. The key challenges are listed below.

- Lack of watershed data, which is one of the most critical missing links in any such project (rainfall, evaporation, land cover, population, terrain, topography and lack of water quality and flow monitoring);

- Inland water pollution mostly due to urbanised watersheds, indiscriminate used water ingress to stormwater drains and solid waste dumping into waterways;

- Inland water pollution mostly due to urbanised watersheds, indiscriminate used water ingress to stormwater drains and solid waste dumping into waterways;

[1] Bengaluru is located on a plateau at an elevation of around 920 MSL. It is divided into three catchments, also known as valleys – Hebbal, Vrishabhavathi and Koramangala & Challaghatta. The study area included entire Hebbal Valley and part of Vrishabhavathi Valley.

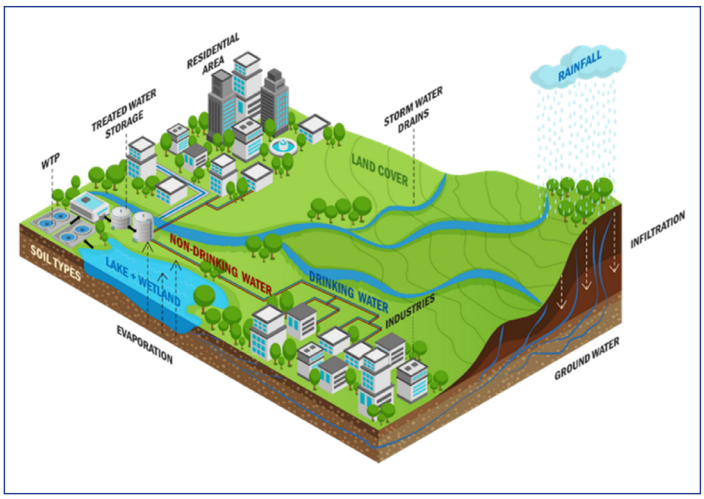

Figure-2: Schematic of collection, treatment and distribution of rainwater as water source

• Flooding during extreme rainfall events, which is now becoming a common problem in big cities that were developed by sacrificing local water bodies and watersheds;

• Lack of stakeholder engagement and making the public a part of large-scale rainwater harnessing;

• Lack of preparedness for climate change.

DATA COLLECTION AND PROCESSING

Secondary and primary data were collected for a comprehensive data analysis. This included:

• Procurement of climatic data including hourly rainfall data and daily evaporation data for the past 40 years,

• Collection and analyses of bi-monthly water quality data available for the lakes within study area (longest available record was for the past 5 years),

• Procurement of the Digital Elevation Model of +/- 3 meter vertical accuracy covering the entire study area,

• Convened topographic survey of 54 kilometres of stormwater drain length, starting form outlet of the farthest upstream lake to the inlet of most downstream lake within the study catchment area,

• Convened bathymetric survey of 22 lakes,

• Water and sediment quality sampling and testing for 22 lakes as well as at strategic locations along the stormwater drain,

• Flow measurement at the outlet drains,

• Groundwater quality testing,

• Analyses of secondary data pertaining to soil and geology for the study area to understand underlying lithology for groundwater recharge,

• Secondary data on lake management practices such as desilting and lake bund maintenance records,

• Current users and uses of lake water,

• Flora and fauna around the lake,

• Used water management practices along with water demand and supply pattern in the study area,

• Groundwater management practices,

• Previous studies and reports pertaining to lake management,

• Study of applicable local, state level and national statutory requirements for lake conservation/management, and

• Identification of key stakeholders to perform a comprehensive watershed hydrological assessment.

Figure-3 shows the condition of stormwater drains and lakes within the study area.

Figure-3: Photos from site visit to observe site condition

Qualitative and Quantitative Assessment of Stormwater

Rainfall is known to have spatial and temporal variation across Bengaluru, and whilst it is possible to generate synthetic rainfall time series that represent the "average" annual characteristics based on recorded rainfall, the entire rainfall record was simulated allowing for a more probabilistic expression of runoff. Therefore, for the purpose of water yield calculations, a long-term simulation, covering 40 years of rainfall, from 1976 to 2016 was considered to account for varying rainfall amounts. The summary of rainfall is presented in Table-3.

Percentile	Annual Rainfall (mm)
Maximum	1,489
99th percentile	1,451
95th percentile	1,356
90th percentile	1,215
75th percentile	1,119
Median	**959**
25th percentile	778
10th percentile	668
5th percentile	600
1st percentile	558
Minimum	535

Table-3: Summary of annual rainfall

Climate Change Modelling and Analysis

Typically, the climate change scenarios for a region are studied with reference to a base year, which according to Intergovernmental Panel on Climate Change (IPCC), is defined as the most recent 30-year climate 'normal' period, and should be adopted as the climatological baseline period in impact and adaptation assessments. As per IPCC standard, the year 1995 represents the baseline year for the thirty-year period 1981 to 2010. In the cases of precipitation and temperature modelled the baseline is provided and one future time slice of 2050. The future scenario model, i.e. year 2050, consists of an ensemble for 40[2] CMIP5 General Circulation Model (GCMs) patterns.

A key assumption used in the climate change modelling is the choice of representative concentration pathways (RCPs)[3] . For this study, RCP 8.5, which represents worst-case concentration trajectories of greenhouse gases causes causing maximum absorption of energy and subsequently maximum rise in temperature (i.e. worst-case scenario) is used in the model. It is noted that this RCP is also representative of the current trend in greenhouse emissions.

Climate change modelling and analysis was carried out to conduct a rapid assessment of the future changes that could be expected to the rainfed resources of the three areas: the Cauvery Watershed, the Arkavathy Watershed and the BBMP area for baseline conditions up to 2050. Baseline rainfall and future changes in rainfall by 2050 were explored for the study areas in addition to the extreme event of extremely wet and extremely dry events (drought) and how the probability of such events will change for the study areas by 2050 compared with the current baseline of 1995.

The key findings for the study area were:

• Increased annual rainfall as a result of increased rainfall intensity. This is expected to result in a 2.5% increase in dry season rainfall and a 9% increase in wet season rainfall by 2050,

• Concurrent temperature increase, leading to increased evapotranspiration, which offsets the increased rainfall and affects runoff volumes,

• A fivefold increase in the probability of dry period from a 1 in 20-year return period to a 1 in 4 year probability.

Year	Median population (in million)	Domestic (MLD)	Non-Domestic (MLD)	Total Water Demand (MLD)
2020	2.9	390	78	468
2035	3.9	520	104	625
2050	5.2	699	139	840

Table-4: Projected population and water demand

Future Population Growth and Impact On Water Demand

Population has been projected into the future for the years 2025, 2035 and 2050. These projections have been taken from the upper end estimates of the population projections carried out BWSSB's Master Plan and Vision Document Study. Where a specific population projection was not available for the year 2025, a linear interpolation, between the figures available for 2020 and 2035 was made. Using these figures, the population was calculated for each hydrological sub-catchment across the study area catchment, and the projected water demand is presented in Table-4.

Impact on Ongoing and Upcoming Water, Used Water and Stormwater Infrastructure Projects

Both BWSSB and BBMP have plans to change the existing treatment, conveyance and storage infrastructure within the catchment. At best estimate, all of these changes are expected to have occurred by 2025 and include:

• The construction of new WRPs (Water Reclamation Plants) within the catchment,
• The upgrade of treatment capacity at existing WRPs,
• The rehabilitation of lakes within the catchment including Puttenahalli and Kalkere lakes.

RESULTS AND KEY FINDINGS

Flood Risk Assessment

Rainfall data along with terrain information helped to create a base map for flood analysis (Figure 4). Various flooding events and intensities

[2] Coupled Model Inter-comparison Project (CMIP) is a standard experimental protocol for studying the output of coupled atmosphere-ocean general circulation models (AOGCMs). CMIP provides a community-based infrastructure in support of climate model diagnosis, validation, inter-comparison, documentation and data access. '5' represents the Phase 5 of CMIP

[3] Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. The pathways are used for climate modelling and research. They describe four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. The four RCPs, RCP2.6, RCP4.5, RCP6, and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 W/m2, respectively).

were mapped for the study area. This helped to locate all the proposed infrastructure outside of the floodplain, thus making it resilient against flooding and sustainable. Besides, understanding stormwater flooding would help BWSSB identify flood prone locations, and help it to upgrade existing infrastructure and avoid capital intensive damage to the City.

Using the flood model, several simulations were carried out to produce flood maps and flows for the study area. These were:

- Five design storm simulations for the 6-hour storm duration, for return periods of 1 in 2, 5, 10, 30, 50 and 100 years,

- The same simulations were repeated for the future scenario in 2025,

- Sensitivity tests to determine the impact of model parameters including:

o Infiltration parameters,
o Sub-catchment shape,
o Channel roughness.

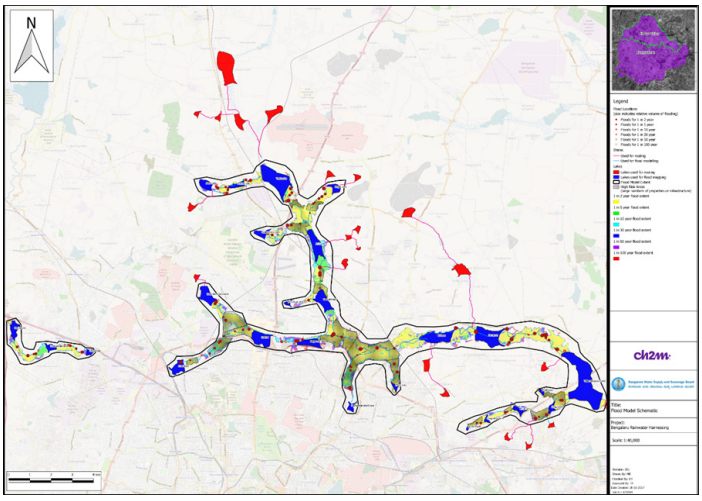

Figure 4: Flooding extent map

Design of Rainwater Harnessing Scheme

The modelling results for future scenarios indicate the following for rainwater harnessing:

- Surface water runoff is already in excess of available storage in the catchment and regardless of the future increase in impervious area, runoff volumes will remain in excess of available storage volumes in the catchment. Increasing catchment storage will increase rainwater harnessing potential.
- Given the likely increase in runoff in the future, but a concurrent increase in the probability of drought, it is recommended to base design options upon the maximum recorded dry period (190 days) to ensure certainty in reliability of any supply.

Figure 5 shows configuration of rainwater harnessing scheme based on lakes as storage units. Stormwater from the watershed is conveyed in a stormwater drain before discharging into the lake. A low flow diversion weir located at the lake inlet diverts dry weather flow around the lake by preventing concentrated untreated used water from entering the lake.

Stormwater then passes through a natural treatment system in floating and marsh wetland located within and adjacent to the lake over a period of time. This treated water will be of good enough quality to be further polished using an advanced water treatment plant (WTP). Based on the configuration, WTP can produce water at drinking or industrial water

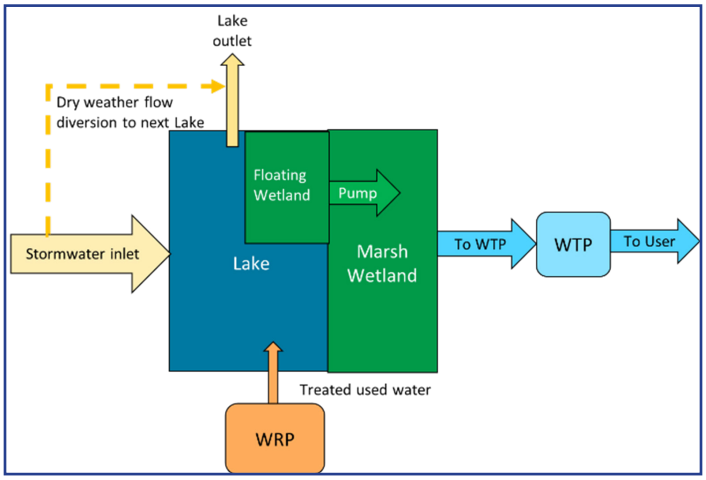

Figure 5: Configuration of Rainwater Harnessing (RWH) scheme

quality.

Developing Rainwater Harnessing Solution

Lakes within the study have been identified as rainwater storage units. There are approximately 45 lakes within the study area that are greater than 2 hectares in surface area. The next challenge that loomed was to identify the best possible lake or combination of lakes that could yield the maximum benefit (in terms of social and environmental perspective) for the least possible cost. A quadruple bottom line (Environmental, Social, Technical and Financial aspects) based on Multi Criteria Analysis (MCA) is the most effective, documentable and logical procedure to refine the choices in an unbiased manner. Jacobs' Multi-Objective Decision Analysis (MODA), a proprietary MCA model was used in this project. MODA was undertaken to weigh benefit-cost for multiple possible combinations over the life cycle of a given system. Factors considered were collected from discussion with various earlier similar projects and BWSSB. Using this logical tool, a list of approximately 168 combinations were narrowed to 4 schemes comprising of single or multiple lake combinations. Figure-6 is a pictorial representation of this logical tool.

Figure-6: Multi-Criteria Analysis (MCA) using Jacobs Multi-Objective Decision Analysis (MODA)

The ultimate success of any project depends on complete commitment and involvement from stakeholders. In Bengaluru there are at least five governing agencies that play a key role in determining the success of this rainwater harnessing project. A key stakeholder meeting was conducted to bring the key stakeholders together and they were requested to give their inputs on best management practices to reduce watershed level pollution.

CONCLUSIONS

Four rainwater harnessing schemes were formulated based on extensive data analysis (both primary and secondary), and through analysis of hydrology and hydraulics using flood and stormwater modelling software. The water yield was then analysed statistically, to arrive at a cumulative harnessable yield of approximately 66 MLD (at 95% reliability), as presented in Table-5.

Table-5: Proposed RWH Schemes and Harnessable Rainwater Volume

Scheme Number	Lakes	Maximum water that can be harnessed from the lakes (dictated by wetland size or lake storage capacity) in MLD#	Scheme Harnessable Volume (MLD)
RWH Scheme 1	Yelahanka	13.2	13.2
RWH Scheme 2	Madhavara	7.5	7.5
RWH Scheme 3	Jakkur	10	23.3
	Rachenahalli	3.3	
	Hebbal Nagavara	10	
RWH Scheme 4	Kalkere	8	22.4
	Rampura	4.7	
	Yellamalappa Chetty	9.7	
Total			**66 MLD**

Notes: #Based on lake deepening, evaporation and percolation losses.

Table-6 provides the total capital expenses, O&M expenses (based on 25 years of operations) and Net Present Value (NPV) for each of the RWH scheme without including land acquisition costs. It is to be noted that an annual escalation cost of 5% and provisional sum of 10% accounting for work charge establishment, miscellaneous and unforeseen charges have been considered in NPV calculations. A discount rate of 6.25% is considered which is based on Reserve Bank of India Repo Rate revised as on 2nd August 2017.

Table-6: CAPEX, OPEX and NPV for Proposed RWH Schemes

RWH Scheme Number	Cost per Kilolitre over 30-year time horizon (INR)
RWH Scheme 1 (Drinking)	₹ 6.3
RWH Scheme 1 (Non-drinking)	₹ 4.8
RWH Scheme 2	₹ 4.1
RWH Scheme 3 (Drinking)	₹ 7.6
RWH Scheme 3 (Non-drinking)	₹ 6.2
RWH Scheme 4	₹ 7.6

Note: 1 AUD = 50 Indian National Rupee (INR); ₹ is the symbol of INR

The proposed schemes are designed to be flexible and scalable, both in terms of quantity and targeted quality. A unique combination of conventional, and natural treatment system using wetland, has been identified to treat harnessed rainwater. The natural treatment systems using floating wetlands in the lakes, can easily be scaled to accommodate more water to be treated, if needed. Flexibility to switch from non-drinking treatment to drinking treatment can be achieved easily by designing a hybrid WTP layout.

Treatment costs for different rainwater harnessing schemes were estimated using net present value (NPV) and life cycle costs (LCC) ranged from INR 4.1 to 7.6 per kilolitre (KL), whereas in Cauvery Water Supply Scheme (CWSS) the cost for pumping alone comes to INR 11.5 to 12.7 per KL. The designed schemes have the potential to provide a valuable contribution to Bengaluru's future water supply portfolio and importantly, also support rejuvenation of the city's historic lakes as focal points for community wellbeing.

ACKNOWLEDGEMENTS

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Challenges of Storm Water Management in Highly Congested Urban Area: A Case Study

Chandranath Bera
Design Expert

Diptarup Kahali
Team Leader, KEIIP
Shah Technical Consultants

Abstract

Unplanned and rapid urbanization changed the hydrological cycle considerably – because of increase of impervious areas and subsequent increased surface runoff, resulting in increase in the frequency and magnitude of urban flooding. To cope with the changes in the hydrological cycle, a well-designed drainage system is needed, but it remains a significant challenge in planning and implementation of the effective urban drainage system in a highly congested mostly unplanned urban area.

This paper presents the challenges faced for development of urban drainage system and measures to be taken to meet those challenges - alleviation of water logging in the south western part of Kolkata city. In addition, it summarizes the approaches and techniques, undertaken for development of efficient urban drainage system in the said areas. Further, it encompasses the hydraulic modelling approaches for city drainage system through Mouse & Mike 11 software to check the hydraulic behaviour of the drainage system and Computational Fluid Dynamics (CFD) simulation of pumping station to assure efficacy of the operation of the pumping station.

1. Introduction

Urban flooding is a major catastrophic trait of many cities around the world, as a result of various known and uncertain factors such as, hydrological changes, rapid and unplanned urbanization, climate change and infrastructure inadequacy. The effect on the local economy is enormous and so also the overall urban environment. Despite development over the years, it remains a significant challenge to design an effective and well functioning urban drainage system to discharge storm water in most cities, especially in developing countries. The recent trends of rainfall runoff due to climate change and urbanization certainly put tremendous pressure on the urban drainage systems. The growth of urban areas and migration to urban from rural areas has resulted in substantial changes in the hydrologic cycle in many ways, such as increased impervious areas and subsequently surface runoff which is due to decreased vegetation cover and open space and infiltration into the ground. That has resulted in substantial increase in the frequency and magnitude of urban flooding in many regions of the world. Therefore, there is an increasing need to improve drainage capacity to reduce flooding, pollution, and risks to health, since the traditional methods of expansion and upgrading of existing urban drainage systems in highly congested area hardly provide any relief.

For the last couple of decades, the Kolkata city, the capital city of the state of West Bengal, has also been experiencing severe waterlogging by the storm water runoff. In order to achieve efficient and effective urban flood risk management, Kolkata Municipal Corporation (KMC) has undertaken some significant endeavour and positive steps towards improvement of sewerage and drainage system through Kolkata Environmental Improvement Project (KEIP) and Kolkata Environmental Improvement Investment Program (KEIIP) with loan from the Asian Development Bank (ADB).

Kolkata city, one of the eight metropolitan cities of India, located on the eastern bank of River Hooghly is over 325 years old. The population of Kolkata City as per the 2011 Census is about 4.5 million.

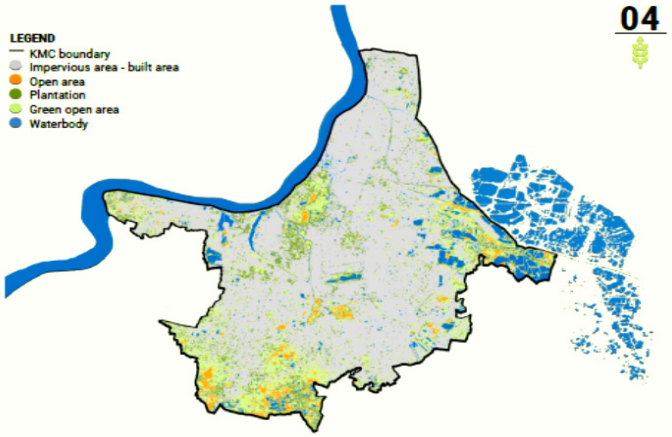

Figure-1: Kolkata Land Use

With passage of time, the city has grown and at present covers an area of about 200 sq km. After Independence, the City area delineation was first changed in the year 1984 when South Suburban, Jadavpur and Garden Reach were annexed to the Municipal Corporation Area (often designated as 'Added Areas') and the last change in the City area delineation was in the year 2015 when the Joka area was annexed to the KMC area.

For the last couple of decades, the City has been suffering from severe waterlogging, while the periphery of the City (Added areas) is inundated most severely in monsoon. Even a light rain floods certain areas of the city for several days and causes serious problems including disruption of traffic movement and normal life.

This paper presents the types of urban water drainage systems, approaches taken for urban flood risk management, measures undertaken to alleviate water logging, and summarizes the strategies, challenges and techniques for development of urban drainage system for Kolkata city, particularly in the south western part of the city (Behala areas) which had been added in KMC in 1984.

2. Status of Sewerage & Drainage (S&D) System in Added areas of the City of Kolkata

The Added areas are virtually devoid of planned sewerage and drainage system (S&D). Several locations within the added Areas are low-lying and prone to flooding even with moderate rainfall. There are areas where the period of water-logging lasts for several days, causing not only inconvenience to residents but also posing a serious health threat. In those areas, urban runoff often mixes with sewage, causing pollution and a wide range of problems associated with the increased risk of waterborne diseases.

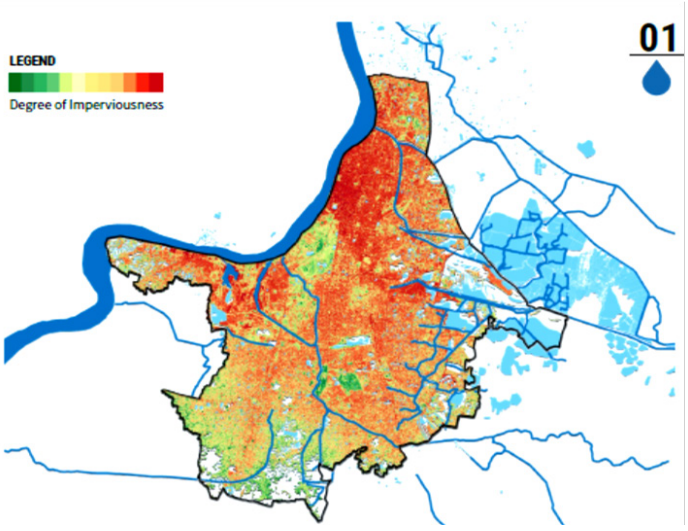

Figure-2: City's Imperviousness

The area after being a part of KMC, has been seen rapid population growth along with substantial increase of industrial and commercial establishments. Accordingly, the landscape of Added areas has been changing rapidly over time due to continuous and unplanned urbanization which ultimately leads to canal encroachment by unauthorized landfilling, illegal construction and expansion of slums over canals, and solid waste dumping. As a result, the areas of wetland and water body has been substantially reduced. This along with the expansion of built-up area are contributing to the collapse of the natural drainage systems of the city. Besides, the canals within the city and surroundings, an important part of the overall drainage system of the city, are illegally encroached, silted up causing considerable decrease in their carrying capacity. The amount of impervious land is expected to increase with time and that might cause more flooding in the future years. Outcome of all this is **extreme environmental vulnerability of the area.**

2.1. Drainage Pattern in KMC areas

Although the River Hooghly is flowing along the western and northern boundary of the city, the natural gradient of the core city is west to east in general. The existing sewerage and drainage network, which was built in the British period in the core city, is also sloped in that direction and the storm runoff of the core city gets discharged to the Kulti River through different drainage channels.

However, a considerable portion of the City area (Added areas and a small part of the core city) gets drained to the Hooghly River through different drainage channels. The entire Kolkata city may broadly be divided into two drainage systems – the Hooghly system and the Kulti system as shown in Figure-3.

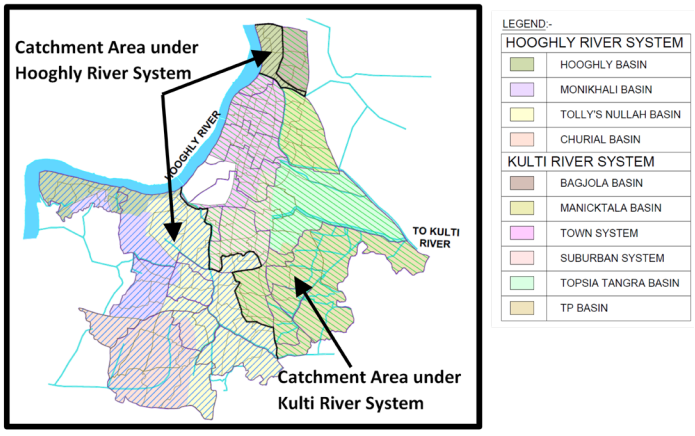

Figure-3: Drainage Basins in KMC area

3. Challenges faced for the development of drainage system

In order to develop efficient drainage system in the study areas, many challenges have been encountered in formulation and implementing the system such as constricted areas, poor road network, narrow roads, non-availability of adequate free lands, existing underground utility lines and tidal influence of the river. They are briefly narrated below:

⁎ Complex and constricted areas. In general, roads in the areas are narrow, which is a big constraint for laying of sewer lines. Due to this, in many roads, it is hardly possible to lay the requisite size of conduits.

⁎ Non - availability of adequate free land areas at strategic locations. Lands are needed for construction of pumping stations as well as for new STP. Government lands are seldom available and for that matter design of the system becomes very complex. Availability of lands at strategic

locations could overcome many problems.

* The canals, which are major drainage outlet of the study areas, have huge tidal influence. It is observed that there is a substantial rise in the water level in the canal during high tides. During such period, the natural drainage gets obstructed, resulting in flooding for long durations.

* Most parts of the area have unplanned road network on account of which, many work fronts cannot be opened simultaneously for construction and the Police and Local leaders also do not allow them because they may cause great inconvenience to traffic movement in turn to the citizens of the locality. As a result, progress of construction becomes very slow and the completion date needs to be extended.

* Considerable parts of the study areas have narrow lanes with abutting buildings/ very old building with weak foundations. While laying sewers in those lanes, the width of the excavation had undermined house foundations in many cases and caused many difficulties to the householders as well to the Authority. Narrow lanes also pose hindrances for access.

* Absence of underground utility maps. Information pertaining to presence of underground utility lines and their alignment are hardly available during the planning stage. Moreover, existing underground services such as gas, electricity, water supply and telecommunications make sewer construction most difficult in narrow confined streets. In most of the stretches, available road widths are absolutely insufficient to shift the alignment of such underground utility lines.

* Poor and inconsistent soil condition also hampers progress of works on many fronts.

4. Design approach for drainage system

For the proposed measures to alleviate flooding in the city, particularly in the south western part of the city, detailed engineering design based on Rational method had been carried out first, followed by hydraulic modelling using MOUSE software (the old version of Mike Urban). The hydraulic modelling of the proposed drainage system was integrated with the canal model (Mike11) with design boundary conditions.

The purpose of the hydrological simulations of the surface runoff and the hydrodynamic simulation of pipe flows was to check the functionality of the network which was designed based on Rational formula and Manning's formula under dynamic load and operational conditions. The simulations operate on the basis of time dependent loads, compute the movement of water on the catchment surfaces and inside the pipe network using Saint Venant's equation which takes into account change in flow characteristics within the system (pressurized/ gravity flow) and considered as a more accurate flow equation. The model is capable of accurately capturing all relevant flow phenomena and also takes into account system retention capacity.

The other purpose of carrying out the hydraulic modelling was to work out the pumping requirement, need for the controlling arrangement (sluice gate/ flap gate) at the outfall end.

The software includes a range of precipitation - runoff models for calculating the runoff from urban catchments and a fully dynamic

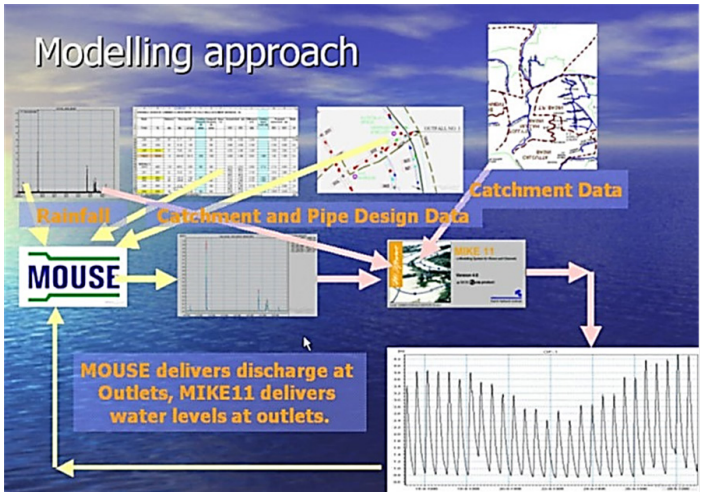

Figure-4: Modelling Approach

pipe flow model for the modelling of flows in complex urban drainage networks. The modelling approach for the drainage system consisted of sewers and canals system. The approach involved two types of models, MOUSE, for the sewer network, and MIKE 11 for the canal system. The two systems interact both ways, with sewer system contributing to the hydraulic loads of the canals and the high-water levels affecting the gravitational drainage of the urban catchments.

Rational Formula is strictly applicable for free boundary conditions and it also does not take into account the retention capacity which absorbs initial impact of any rainfall event. Hydraulic modelling had been carried out to have a fair idea of hydraulic behaviour of the system in different conditions as well as to assess the parameters listed below:

- System capacity,
- Performance of different outfalls provided,
- Adequacy of sizing of different system components,
- Extent and duration of flooding that may persist even after implementation of the system,
- equirement of pumping station including capacity of storm pumps,
- Flow rate and depth through different sections of the system, extent of surcharge or surface flooding, and
- System emptying time i.e., the time required since recession of the rainfall event to evacuate entire storm runoff from the drainage system.

As per the design approaches mentioned above, the storm water drainage system of the study area had been envisaged based on the following parameters:

There is no fixed trend of occurrence of any rainfall event.

The design of the drainage system of the area is carried out considering 2 months storm frequency,

Narrow road widths and poor road network. Major portion of the areas has got unplanned growth with predominantly narrow and circuitous road network.

Extremely difficult to provide conduits of adequate size in many areas even for 2 months frequency.

The analyses reveal that the system would cater only for runoff for the designed frequency. There might be more intense rain beyond the designed storm frequency which would have to be handled by increasing operation of storm water pumps to minimize the extent and duration of flooding.

Discussions & Conclusions

In order to develop, efficient and organized drainage system, following major measures, are to be undertaken during planning and implementing period, considering the various constraints in the study areas for development of the drainage system by conventional method.

Figure-5: Waterlogging in Added areas

4.1. Measures for planning & formulation of the drainage system

• Drainage system had been generally developed by conventional practice using rational method for runoff computation and Manning's formula to determine the pipe sizes to cater to the design discharge. The inherent weakness of the conventional practice of drainage design are that it is applicable for free boundary conditions, uniform flow, fails to take into account any flow back-up due to downstream boundary conditions, etc. To overcome the above limitations, hydraulic modelling by Mouse software for pipe network and Mike 11 for canal using time-series variation of rainfall pattern and variation of water level at outfall locations was considered.

• The drainage system as well as canal improvement works had been carried out, considering 2 months storm frequency with 70% - 90% imperviousness. Storm water flow carried by the system would be disposed off to canals either through gravity outfalls or through pumping.

• In general, government lands for construction of pumping stations/ STP are preferred for formulation of the scheme to minimize land acquisition issues.

• All the outfalls are proposed to be with controlling arrangement (sluice gate/ flap gate) to prevent possibility of intrusion of canal water into the drainage system during the high-water level state in the canals.

• System planning and design was carried out in such a way that the storm water can be evacuated from the areas during high water level in the canal due to tidal lockage and with gates in closed condition.

• To maintain low water level in the canal, canal pumping stations were proposed at the confluence of the rivers (Hooghly River/ Kulti River).

• Catchment delineations had been done duly taking into consideration the existing drainage system of the area, ground topography, existing road network, catchment area of outlet canals and particularly narrow road width to lay conduits of size matching with the design requirements including availability of space for construction of pumping stations, location of sewage treatment plants, etc.

• Looping arrangements/ overflow arrangements were proposed within the network at strategic locations to facilitate better functioning of the system and distribute the storm load uniformly in the catchment area which would also facilitate to reduce sewer size along certain roads which otherwise would be difficult to execute. The actual hydraulic behavior of the system after introduction of the above was substantiated by hydraulic modelling analysis.

• Storm water pumping regimes were finalized based on the location and area of the land. In accordance with that, the drainage network was modified in such way that the pumping stations could serve bigger areas.

• For a few pumping stations, due to acute space constraint and the need of accommodating more number of pumps in the restricted diameter of the sump well, Storm Water Flow (SWF) pumps had been considered for installation in 2 clusters (Rows) in a well. The spacing of SWF pumps had been maintained as per guidelines of the Hydraulic Institute Standard.

• To check the hydraulic behaviour of the modified arrangement of the SWF pumps in two cluster, Sump model study/ CFD (Computational Fluid Dynamics) were carried out to ensure vortex free/ cavitation free operation of SWF pumps. That would increase the longevity of the pumps sets and the electro–mechanical installation and improve the efficacy of the operation of the pumping station.

4.1.1. Hydraulic Model Analysis

Hydraulic modelling analysis had been carried out to check the behaviour of the drainage system with downstream boundary condition. As a case study, the outcome of a hydraulic modelling for a drainage network within the study area is presented below.

Performance of the system under the different scenarios (keeping pump capacity for Scenarios 1 to 4 is 2600, 3400, 4200 & 5000 lps respectively) had been analyzed considering water volume generated during the design rainfall event and the system volume. Water volume exceeding system volume indicates that at certain stages of the rainfall event, the volume of surface runoff exceeds the system retention capacity, which results in flooding. Figure-6 illustrates the model output of storm water evacuation performance of the system.

The total volume of the sewer network in the study areas under hydraulic

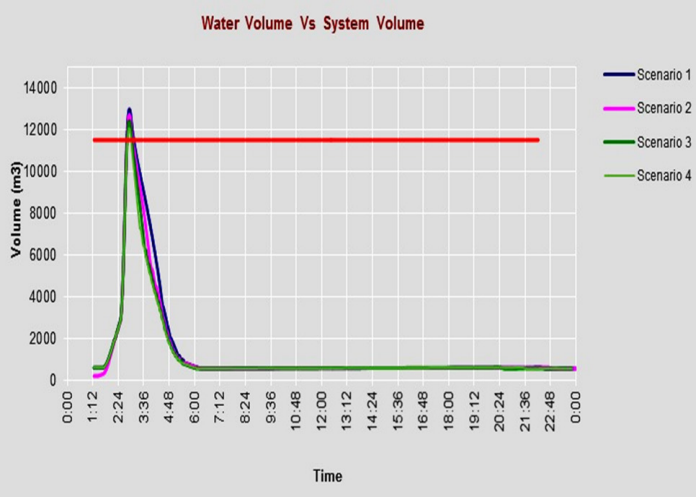

Figure-6: Storm Water Evacuation Performance of the System

modelling analysis was about 11,537 m3 (shown by red horizontal line). During the design rainfall event, storm runoff fills the network, at the same time water is drained out of the system by pumping and through outfalls. It was observed that there are identical situations under all the scenarios. That indicates that the system emptying time is almost the same under all simulations and in accordance to that the pump capacity of 2400 lps (scenario 1) is finalized. Figure-7 and Figure-8 present the maximum extent of the inundation and inundation after 30 minutes from start of inundation under Scenario 1.

The blue patches indicate locations of inundation. The main causes for such inundation are: (1) very high water level in the canal, (2) long distance from the pumping station and /or outfall, and (3) low terrain levels at the upstream end of the sewer. However, these short-term inundations are not seen as a major functional problem under design rainfall. It is found that Max. Inundation period is about 45 minute and occurs in a small area.

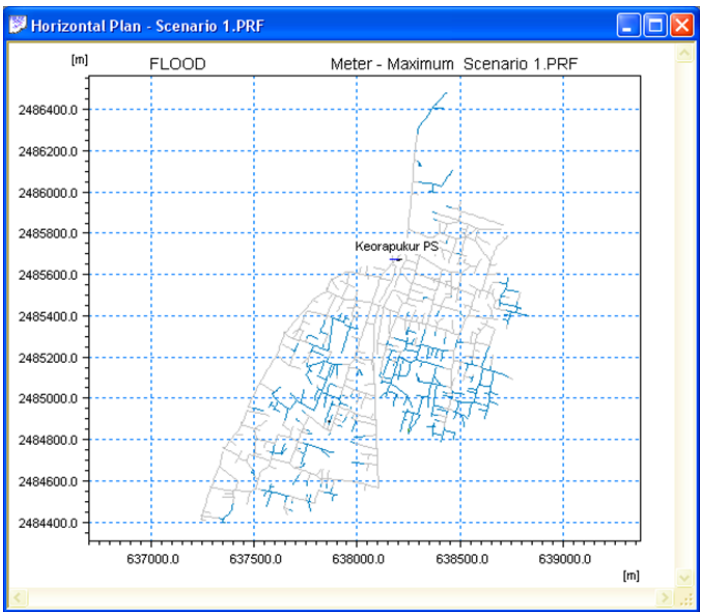

Figure-7: Max. Inundation under Scenario 1

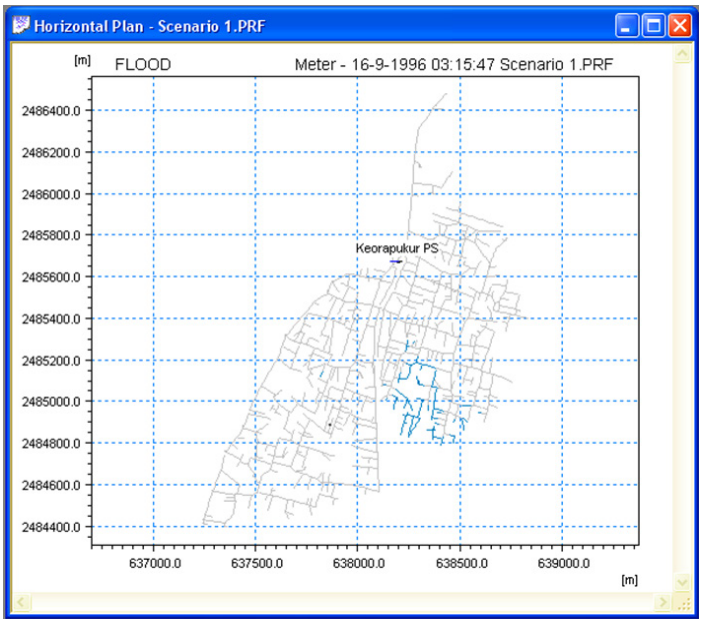

Figure-8: Inundation after 30 minutes from start of inundation

4.1.2. CFD Simulation of Pumping station

Free surface vortices and submerged vortices can also influence pump operations. Strong free surface vortices may cause air to be entrained into the pump, potentially resulting in loss of priming and loss of pump capacity. Submerged and free surface vortices entering the pump, even without air entertainment, would impose a fluctuating load on the pump impeller blades as each blade passes through the lower pressure vortex core.

4.1.2.1. Recommendations

In many cases, one of the recommendations was the provision of cross type vortex breakers which would help to further improve the flow profile inside the bell mouth of the pump suction. Concrete cross splitters were provided below the bell mouth as shown in Figure-9

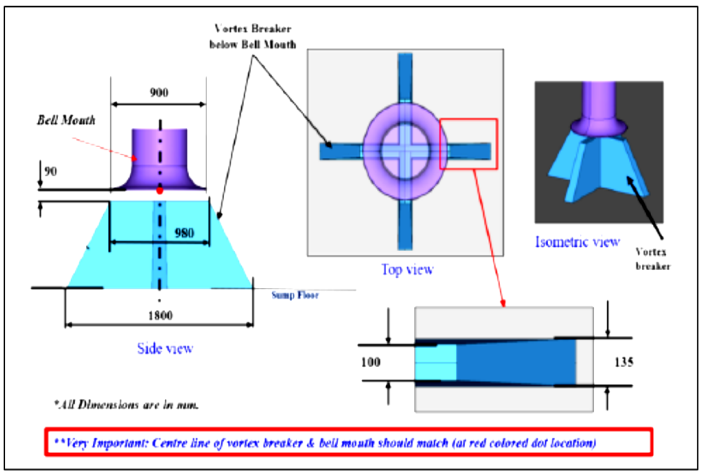

Figure-9: Vortex Breaker below Bell Mouth

For some cases, it was considered necessary to provide baffle walls and curtain walls in accordance with the Hydraulic Institute Standard.

4.1.2.2. Benefits of Cross Type Vortex breaker below Bell Mouth/ Cross Baffle Walls

• The vortex breaker helps to reduce formation of swirling in the flow below bell mouth.

• The vortex breaker helps to reduce entry of sub surface vortices inside bell mouth.

• As the swirling in flow below bell mouth is reduced, it further helps to improve flow profile inside bell mouth.

4.2. Measures against Challenges for Implementation

⁎ Laying of sewer using trenchless technology along major roads, road with heavy traffic/ road congested with utilities was considered. It is a much faster process of execution, at the same time requirement of traffic diversion is also much less. Traffic diversion is only required at locations where driving/ receiving pits are to be made.

⁎ At several locations the soil condition was found to be poor with instances of sand boiling. The water table was also found to be very high. Deep trench excavation for pipe laying was thus a challenge in such areas. In certain areas, the work could be taken-up only after stabilizing the soil by special treatment.

⁎ Close co-ordination with public representative and stakeholders was maintained throughout the project for smooth execution of the project.

⁎ Close co-ordination with different agencies of utility services to reduce time of obtaining approval and getting utility lines shifted.

⁎ GIS (Geographic Information System) mapping for mapping of underground utility lines was taken up since it was essential for future development.

After implementation of the scheme in some areas, significant improvement in the drainage system were noticed. Lesser water-logging episodes had been observed in those areas and even if the same had occurred, the situation did not last for a long period.

The change had come because of the projects taken up by KMC. They may not have completely solved the water logging problem but it had substantially reduced its impact. Certainly, the endeavour of KMC for the improvement of the city drainage system especially in the Added areas would improve the overall living standards of the citizens.

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Shah Technical Consultants Pvt. Ltd.

Shah Technical Consultants (P) Ltd (STC) is a consulting firm specializing in the Environmental Sector with special focus on all aspects related to drinking water, sewerage, **urban drainage** and solid waste. STC has worked on consulting assignments for urban drainage projects for major cities in India including Mumbai (including Suburbs and Metropolitan Region), Kolkata, Jaipur, Jammu, Cuttack, Nagpur, Thiruvananthapuram, Aurangabad, Pimpri-Chinchwad, Dibrugarh, Chindwara and many more. Most of the projects have been in congested areas and involved innovative solutions to overcome the city specific issues.

Flood Control Management in Built Environment

Er. Ronald Valledor Gomeseria, Ph.D. MCEAI MIE
PE, PME, PMP, PEng, CEng, CEnv, CBuildE, ASEANEng, ACPE, IntPE
WhelAje Engineering Consultancy – MEPFS & Environmental Consultant
Flood Control Asia – Head of Engineering

Overview

The word "Flooding" is very common now and a major cause of concern in many parts of the world because of its dynamic effect on lives of humans, animals, properties and other assets. A flood is due to wet environmental conditions that cause the moisture content of the soil to rise much above the normal conditions and hence the water does not get absorbed and that results in collection of water above the ground level. This has been discussed in the author's article ***"Does Climate Change Impact our Environment?"*** ResearchGate/LinkedIn platforms, June 2021. Therein it is mentioned that, "…with tropical areas like the Philippines with archipelagic locations, it is indeed that Climate Change impacting and suffers the entire environment. And as a consequence of this phenomenon, the cause of the flooding is more frequent and intense throughout the archipelagic terrain of the country due to the low pressure that has been developed in the Pacific Ocean especially whenever typhoons" occur. These elements as well as heavy rain conditions contribute to significant flooding occurring in cities and municipalities, result of rising water levels in drainage system because of water coming in from different sources of drainage connections and being let into rivers, streams, lakes and sea. The water levels in those also consequently rise and many times go above the bank levels.

Nobody can control Mother Nature; however, human can minimize or mitigate the risks that can arise and cause floods, through careful studies and investigations of the affected areas and then draw up flood management plans. The flood control management plans could be either within the built environment or even outside it. It is advantageous while preparing the emergency flood management plan to incorporate the four phases of the process starting with planning for flood mitigation, preparedness, response, and recovery. The four phases are as used normally in planning for Disaster Resilience. Flooding mostly affects low lying areas but could also affect others where the land use and drainage system are not thought of with a long term view and planned properly.

Infrastructure and Environmental Development

The development of the infrastructure in a locality is key to the prevention of a flood. The Surface Ground Water Network (SGW) has to be planned and managed after a careful study so that even if the stormwater level rises, the flow can be led in one direction through spillways into a water basin by gravity, like for example by providing a dyke as shown in Photo-01.

An alternative solution would be to provide a pumping station, which is more advisable, with multi stage pumping so that the flood water could be discharged and pushed immediately to a river, streams or sea

Another alternative would be to use the Flood Control System Technology (FCST) which is now in the market to help support in protecting assets in the built environment, albeit temporarily. It can be incorporated in the building design proposals to suit the requirements within the built environment as part of flood control management. The infrastructure has to be developed first with an alternative solution for diverting very large stormwater overflows to a nearby waterbody by providing flood control and mitigation measures as shown in Photos-01 and 02 so that the buildings and homeowners in the low lying areas could have peace of mind. There could be other alternative ways of mitigating but a proven solution to the problem of preparedness, which is doable in the first place and by which everyone is a beneficiary.

Protecting the environment is essential for all communities, however, in some parts of the world, economic priority to alleviate growing poverty is also a necessity. Rehabilitation of all Surface Ground Water Network (SGW) Drainage of a country would also help in uplifting of the economic conditions, by educating all governmental agencies and private sectors of the urgency and dire necessity of preserving, growing and spreading the forest covers for a sustainable future. However, it is also necessary to understand the dichotomy of economic development that has led to environmental degradation and the consequent disasters. They must be studied carefully and holistically for a sustainable ecological solution.

For the study it is essential that the importance of Climate resilience and its situational based effects on the built environment and other infrastructure are understood. The effect on the environment using adaptation and mitigation, preparedness, response, and recovery processes need to be developed in a comprehensive manner and be presented in a such that every citizen can understand. That would help them to acknowledge, accept and adjust to the growing global climate change issues that have resulted in extreme disasters.

Inspite, of all the climate change effects, it may not be feasible for economic reasons to hold industrial growth which is an essential part of a country's development, but the energy it requires would always

contribute to emissions of Green House Gases (GHGs). Then there is deforestation, excavation of lands, cutting of mountains and water pollution from industries which all cause denudation and degradation, all eventually leading to flooding and other disasters.

One of the examples of flood control management done in Philippines is the 415 meters San Isidro Flood Control to safeguard Palo Municipality area from the massive overflow of the San Isidro River in Leyte Province.

Photo 01: San Isidro Flood Control Dyke

Photo 02: Flood Control Pumping Station

Seven-Tips for Flood Prevention

Heavy rains are being experienced in many countries of the world and there is no plausible reason to explain except attributing it to Climate Change or an El Niño year. The question that arises is whether it is so, since the reality is that torrential rains are occurring every year.

Africa and the Middle East on the other hand have been experiencing severe drought over the past several years, but heavy rains do unexpectedly occur in some of those countries. In those places many homes and infrastructures in the built environment are not equipped to cater to such heavy rains and that leads to severe flooding issues. The author's article ***"Seven-Tips on Flooding Prevention when Heavy Rains Comes,"*** has provided some tips that might help to prevent flooding. The article is based on experiences in the design and construction industry.

Photo 03, Storm Drains with Catch Pits

Photo 04, Designed Culvert Drainage

Tip No 1 - Clear all Storm Drains

In all new buildings to be constructed, all necessary stormwater drains should be provided and designed in conformance with the National Plumbing Code so that the stormwater would flow to the storm drains (Photo-03) and thence to the drainage culvert (Photo-04).

The drainage system for each building comprising the rainwater inlets, pipes, outlet with proper rodding/ cleaning provisions and connection to the public/ municipal stormwater drain system should be designed to cater to the rain intensity and duration as per codes and standards and if necessary, provided with a safety factor for anticipated increase in the rainfall intensity and duration. The planning and design of the roofs of buildings should be done with proper slopes towards the rainwater outlet, adequately distributed along the perimeter of the building's roof, keeping architectural aesthetics in mind. Similarly, the drainage of the ground adjoining the building should also be provided with collection points and connected to a pipe system and led to the out let connecting to the public/ municipal drain.

For existing buildings, the stormwater drains should be reassessed and repairs/ modifications caried out, if necessary. Where there are chances that an inlet could get clogged due to leaves, debris, etc. different inlet guards and/ or additional inlets could be provided. The intent is to ensure that all the stormwater drain points within the built premises are free to let the rainwater in without any restriction and function as intended, (Photo-04).

Tip No 2 - Clean the House Gutters and Rain Water Downspouts

Whenever alerts from the meteorological office, news agencies or government's disaster risk management council are given regarding heavy rains and typhoons, the building engineer should prepare for it to ensure the building's safety.

An important requirement is that the building's rainwater inlets, gutters, downtakes, etc. be inspected and cleaned of all leaves, trash and other debris (Photo-06), which could be clogging them and could block the system and chock it. If necessary, a diversion pipe could be routed directly to the stormwater drainage culvert outside the premises (Photos-03/04). Collecting and conveying rainwater properly would also prevent damage to the building's foundations and grade (Photo-05) and avoid expensive repairs. Keeping the rainwater drainage system clean is essential for a sustainable environment.

Photo-05: Gutter w/ Downspout Connection

Photo-06: Tree Leaves and on Gutters

Tip No 3 - Sump Pump Installation

Building sump pumps are usually provided to prevent flooding during heavy rains. On the other hand, if the building is located within a flood zone, having a sump pump in the building is essential for conveying the rainwater to a surface groundwater manhole.

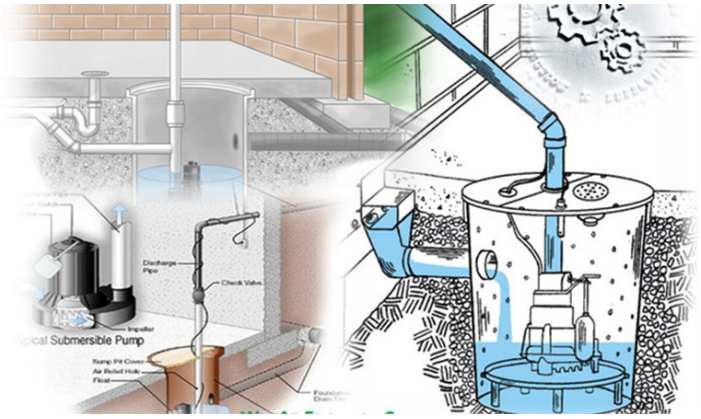

Photo-07: Building Sump Pump

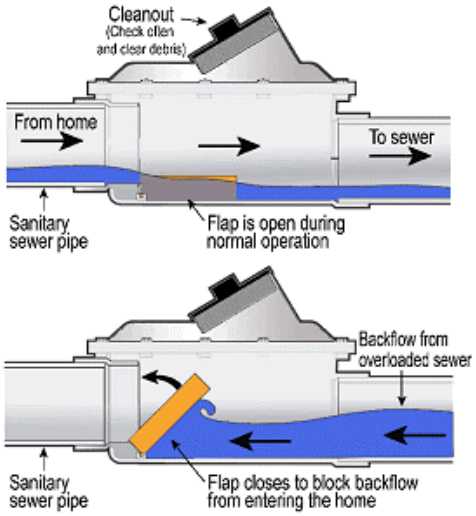

Photo-08: Sewer Backflow Prevention Device

In buildings with basements, sump pump provision as shown in Photo-07 has to be provided to cater to the stormwater to prevent flooding of the basement as per the National Plumbing Code.

The ground/ grade area around the building as shown in Photo-05, should have slopes towards the gratings of the drain channels. The channels would of course be led to the sump pit. Whenever the rainwater enters the crock of the sump pump within the sump pit (Photo-07), it would automatically activate the pump and the stormwater would be pumped out to the public/ municipal system for proper disposal (Photos-02/06).

In case no sump pump or alternative means have been provided and the building is in a flood zone, it is advisable to install a sump pump. The sump pump should be provided with a battery backup since heavy rains are usually accompanied by a power loss or "brownout".

Tip No 4 - Backflow Prevention Device Installation Provision in the House Sewer

Backflow occurrences may occur during or after a heavy downfall if the public/ municipal stormwater system gets chocked/ blocked or is unable to cater to the flow. The public/ municipal system could be chocked/ blocked if not properly maintained or there could also be breakage in

the pipe system. Backflow within the built environment is messy and has health impact apart from cost implications and damages the properties. Backflow could also occur in the sewerage system. To cater to such an eventuality a Backflow Preventer (Photo-08) has to be provided at the connection of the building system with the public/ municipal systems. Backflow prevention devices help to maintain a healthy environmental and proper functioning of the buildings stormwater and wastewater systems.

Tip No 5 – Sandbags Installation before Heavy Rains

Sandbags are one of traditional barrier system for flood defense that have been used by many to redirect the flow of water. They are also used to trap water during heavy rains to prevent flooding (Photo-09). However, it is important to lay the sandbags correctly, since improper setup could give problems. Using sandbags is inexpensive but looks dirty and takes up space but they are good to have on hand for an emergency.

Photo-09: Sandbags barrier to prevent flooding

Photo-09: Sandbags barrier to prevent flooding

Tip No 6 – Demountable Flood Control Barrier System

With technological innovations, other means to create a Flood Control Barrier (Photo-10) have been in use in some countries of Europe. They are simpler to install than sandbags and are sustainable. The barrier system manufactured in Germany is made of aluminum with light material composition, but is costlier than the traditional sandbags.

Photo-11: Clogged Drains causing Flooding

Tip No 7 – Cleaning Clogged Drains

Photo-11 shows a clogged drain due to irresponsible disposal of waste - leaves, trash, plastic bottles, plastic bags and other debris. Drains need to be cleaned before the rains so that they would be able to convey the stormwater and not let it flood the area served. Cleaning of drains is also necessary to prevent damaging the stormwater pumping station.

Environmental Impact Assessment for the Plumbing System

In the author's paper ***"Sewage Water & Surface Groundwater Services Network Design & Stakeholder Management,"*** (ResearchGate and CEAI's ViewPoint, September 2020), the importance of the Environmental Impact Assessment (EIA) report has been discussed and the same is reiterated in this article to emphasize on how to prepare and develop a report about the existing building drainage in a built-environment.

The development of an EAI for a project requires a number of site visits, consultations with the respected regulatory authorities, and investigations by independent sub-consultants so as to arrive at an appropriate solution for the project.

The assessment of the impacts should take in to account the client's vision and specific requirements for the project and should be prepared in accordance with the codes, standards, laws, and regulations of the country. It should also be developed in line with international best practice guidelines and environmental parameters based on the following methodology:

• Contacting academic/ interest groups to identify available environmental data for the development area,

• Incorporate stormwater and sewer backflow valve preventers in the building systems to prevent flooding by backflow,

• Undertaking baseline walkover assessments of the proposed application of backflow valve preventer in the building system, in the surrounding area to gain an appreciation of the overall landscape and demographics,

• Conducting extensive surveys of the ecology and archaeology of the building site area,

• Ensuring the assessment, as far as possible within the defined scope of work, that the existing environment as defined within the priority issues is not compromised,

• Identifying all practical and applicable mitigation measures for all the potential negative impacts that are identified during the process, and

• The EIA, therefore, should ensure compliance with the international best practices, authority regulations, environmental law, national plumbing codes, and local code standards including adherence to the UNDPs principles of sustainable development.

All assessed environmental drainage impacts should be categorized as being either significant or insignificant, because, that is the vital point in determining priority impacts that would require the development and mitigation measures for the use of stormwater and sewer backflow devices. As mentioned earlier drainage or sewer backflow from the public/ municipal system has an adverse environmental impact and must be checked as part of the individual building's flood control management. To reiterate the Causes and Effect of Stormwater/ Sewer Backflow, which could be triggered by the following:

• Drainage Pipe Blockages: this could happen either in a private or city stormwater/ sewer pipe and could be caused by tree roots, leaves, trash, construction debris, construction mishaps, building plumbing system deterioration, and other debris (Photo-11),

• Non provision of oil/ grease traps in kitchens, garages, etc. and gully traps in open areas,

• Intolerable cracks in pipes of the plumbing system,

• Improper pipe ventilation provided in the plumbing system

• Stormwater / Sewerage system back-pitched in the plumbing system

• Surcharges in the stormwater/ sewer line due to heavy rain that cause flooding; and

• Increase in population density which results in the capacity of the public/ municipal system being exceeded.

Conclusion

For improving the quality of the built environment, it is the public who needs to escalate the matters but at the same time abide by the policies and procedures in conformance with environmental laws so that the quality of life for the citizens would not be compromised. To address all the four phases a situation's analysis process through mitigation, preparedness, response, and recovery to address flood issues, the author has provided "Seven-Tips on Flooding Prevention when Heavy Rains Comes," and the use of "Environmental Impact Assessment for the Plumbing System" as discussed. Thus, with a methodical approach, flood control can be managed within the built environment.

Involvement of all governmental agencies, corporates, industries, manufacturing units, and developers is necessary, they must common together and proactively strive to adopt and adapt the most effective policies and technologies to protect the environment and the built assets for better quality of environment and life.

Consulting Engineers, Scientists, and Volunteers can help in implementing the environmental laws and implementation of flood control measures and their management in the built environment.

Recommendations

The structured landscape and biodiversity should be reinstated for preventing flooding in the built environment by planting more trees and developing of spillways, dykes, etc. to end the tragedies and accidents that happen during rains.

UNDP's Sustainable Development Goals need to be kept in mind because that would help in the governance of the systems, once they are incorporated into a country's environmental law. Flood Prevention Planning should be carefully studied and addressed as a holistic approach to planning.

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Saga of the Engineers

Engineer means Ingenuity
Technique, Skill and Improvement
The Servers of Humanity
For a Sustainable Development

If you Miss me in a Party
Look for me in the Jungles or the Hills
If I am Absent at your Club Lawns
Find me in the Mines or Mills

Chorus:

[B'coz Engineers We are
The Soldier, the Unseen Guy
But You can Always Feel our Presence
On the Land, and the Water or the Sky]

We Turn the Wheels of Progress
The Load We Carry is Hefty
But Our Silent Sunburnt Hands are Working
Tireless for Your Safety

We Fill Your Days with Comfort
We Light your Darkest Night
& We Stand by You as a Trusted Friend
Always, With All Our Might....

Repeat Chorus (to Fade Out)

[B'coz Engineers we are ..../ ..... and the Water or the Sky]

Lyric & Music

Prof. P. R. Das ("Ranjan Prasad")
Retd. Chief Architect
Government of West Bengal

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CEAI NEWS

WEBINAR SERIES ON *"CONNECTED BIM FOR INFRASTRUCTURE"*

M/s. Capricot Technologies Pvt. Ltd. in association with CEAI organised a series of 4 Webinar on 9th July 2021 on the following topics:

Connected BIM for Roads & Highways

The matters presented were:

- Existing Conditions Modelling
- Detailed Design
- Survey & Planning
- Documentation
- Preliminary design
- Coordination and Visualization

Connected BIM for Rail

The issues covered were:

- BIM-GIS connected workflows for Site Planning & Feasibility Analysis
- Detailed Design of Rail Tracks, Stations and other Ancillary Buildings
- Design Automation on Rail Projects
- Common Data Environment
- IOT and Advances Analytics for Real-time performance monitoring

Connected BIM for Water & Wastewater

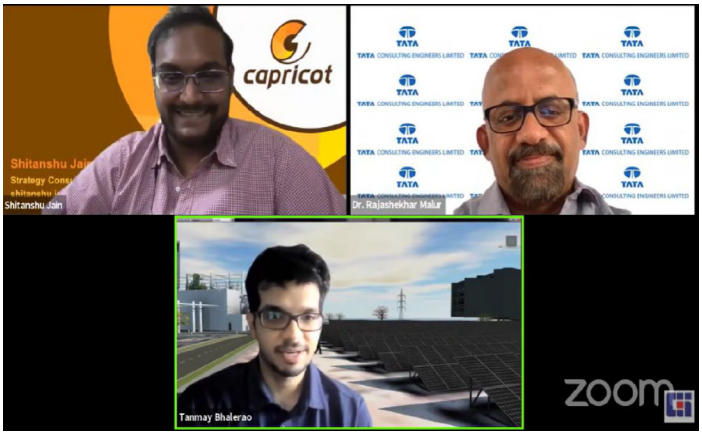
The topics discussed were:

- Establishing Existing Conditions
- Piping and Equipment
- Surface Water Networks
- Clash Detection
- Site Grading
- Collaboration
- Plant Building Creation
- Visualization

End to End Solutions for Solar Projects

The session covered:

- Existing Conditions Modelling
- Yield estimation and simulation
- Solar Plant – Site Layout & Detailed Engineering
- Construction Monitoring
- Structural Design, Analysis & Modelling
- Operations and Facility Management
- Electrical Utilities



WEBINAR ON *"INTELLECTUAL PROPERTY RIGHTS"*

Consulting Engineers Association of India (CEAI) through its Western Region Centre organized a webinar on a 'non-engineering topic' on 15th July 2021 to create awareness regarding "Intellectual Property Rights" and to help professionals monetise their innovations and inventions which they do to fulfil the requirements of their work by safeguarding that knowledge and use it gainfully. The webinar covered the value of data as an intangible asset and how to leverage IP strategy to drive business value.

Mr. Uttam Sengupta, Past Chairman CEAI-WRC, Mr. A P Mull, Past President CEAI, Dr. Harshavardhan Subbarao, Chairman CEAI-WRC and Mr. Jeffrey Nambiar, Hon. Secretary and Treasurer, CEAI-Western Region Centre (CEAI-WRC) organised the webinar with the support from Lex Mantis, Advocates & Legal Consultants.

Mr. Uttam Sengupta introduced himself and also the theme of the webinar. He thereafter requested Dr. Ajay Pradhan, President CEAI to share his thoughts.

Dr. Ajay Pradhan accorded a warm welcome to everyone and in his opening remarks said that although it was a non-engineering topic, it was very important for engineers to understand the subject, especially when Data is emerging as an important factor in the day-to-day business. He briefed the participants about CEAI as being the representative body of the Consulting Engineers and also a Member Association of FIDIC in India.

He then moved on to the topic of the day - Intellectual Property Rights (IPR) and said that it related to what is created by the human intellect of engineers, consultants and many other professions and is thus an important aspect of the business that they are in and from where their money comes. Therefore, that kind of knowledge needs to be recognized and be protected from being copied. He also added, that although any idea has a short life, its application in many instances can be appropriated effortlessly. Thus, not having a proper mechanism in place could be dangerous, hence there was need to look at how to maintain IPs and IPRs.

To drive home the point of how necessary it was that Consulting Engineers in India use it as a business avenue, Dr. Pradhan then gave an example of a case in one of his projects – a project in Manipur, where around 2000 acres of marshy area called Lamphelpat was to be converted to a flood water holding reservoir and other environment friendly uses. To connect the north and south part of the holding reservoir (lake) necessitated the creation of a bridge. While looking at the options they came across a light steel structure design road cum pedestrian bridge. They selected a bridge but later found that there was a copyright issue with that design. An American company had a copyright for some part while the rest was still being possessed and also copyrighted in Europe but not in India. Hence, although that design could have been used in India, it would still have been a violation. Those are the issues which consulting engineers have to address. Similar considerations of copyright could also apply to data taken from Google search. He then showed a network for flood forecasting – "Real-time Urban Flood Monitoring and Management System", which required a number of sensors. Ofcourse they could be bought, so also the software and the equipment, but again the use of certain processes involved copyrights issues. Royalty payments were involved for using the process. Consulting Engineers who need to use data, designs or networks or systems or processes quite often face such issues. They need to know how to protect the copyright of the documents they create and parallelly honour others copyrights. He urged everyone present to imbibe the knowledge from Ms. Anuradha Maheshwari and use it in their businesses.

Mr. Uttam Sengupta thanked Dr. Pradhan for giving a practical insight into the subject. He then invited Ms. Anuradha Maheshwari, Founding Partner, Lex Mantis to make her presentations on ***"Value of Data as an intangible asset"*** and ***"Leveraging IP strategy to drive business value".***

Ms. Anuradha Maheshwari informed that IP is varied and complex; hence, she gave a broad and basic insight into the legal subject and explained as to what it dealt with. She next outlined the scheme of her presentation.
For the first topic, **"Value of Data as an Intangible Asset"** she showed the image of a Rubik's Cube, an interesting toy made by a Hungarian, Mr. Enró Rubik at the young age of 29 years, who became a multi-millionaire simply by riding on the small item – the Rubik's Cube, a complex item but looks so simple; it looks stable but is dynamic – there are colours, a scheme, pattern and it's a mark of extreme intelligence. A Patent for the cube was applied in 1975 and it was licenced to Ideal Toys Corporation in Europe, in 1980. Within a few years over 350 million Rubik Cubes were sold worldwide. The Patent expired in 2000 and thereafter it came into public domain. It became a benchmark for further innovations on that toy which has 443 quintillion ways to scramble the Rubik's Cube and each permutation can be solved in 20 moves or more. It has 50 million knockoffs (copycats) and at least 10 million books on how to solve the Cube. The imitations are still going on. That makes one understand a very critical phenomenon, and that is that entertainment is very fundamental and essential to human lives, and therefore entertainment is big business.

Talking about the Value of Intangibles, Ms. Maheshwari said that great inventions of man have been property, God, a company, marriage; all these are legal constructs. Immovable property was started to be claimed first. Property is not natural, no one is born with property, it is inherited. It is a man-made legal construct.

Over a period of time men started understanding that there was also great value in things that are untouchable, in the sense that one cannot touch and feel. They understood that things like reputation, a great idea which is successful and can be sold, can be called as a man's property. Hence, over a period of time 'ideas' in inventions, innovations came to be called as intangible property.

The division between property is Immovable property and Movable property. The latter again broke up into what is Intangible and Tangible property. For example, stocks and shares are intangible properties and people trade in them. The concept of Intellectual Property came in around 500 BC and today it is a very well regulated and a well-entrenched system.

Ms. Maheshwari presented a snapshot of the evolution of man in terms of man's ideas. The top innovations shows that Internet is completely dominating and ruling men's lives today. The others are the Computer, Light Bulb, Compass, Semi-conductors, Written language and the Wheel and Axel, which were milestones in the evolution of human existence. However, today great design thinking examples are completely intangible; they are great concepts, which have become best sellers and over which great companies have evolved and are carrying on business - Airbnb, PillPack, Clean Team, IBM, Stanford Hospitals, Uber Eats, Zomato. "… the last one which I personally think is great in terms of intangible in terms of concept and that is Sulabh Sauchalaya. It has been a great successful model all over the country."

Regarding Intellectual Property, Ms. Maheshwari explained that to create proof of an idea it must be translated from a pure idea to something tangible. IP can then be used, accessed, distributed, willed, gifted, assigned, sold, etc.

Copying is very natural to man, but man realised that stealing and copying were not a healthy habit, especially if it deprived the originator of a particular idea from commercializing his idea. That gave rise to competition laws – about fair and unfair competition. She gave the example of losses suffered by Ford Motor company caused by unfair competition, stealing of data. Other examples – as per US Federal Administration, 520,000 counterfeit parts are installed in aircrafts every year. The Motor Equipment Manufacturers Association cites that 1 in every 3 auto parts are copied in the US. In India, auto components auto counterfeits erode the market share with losses of Rs. 9000 crores. Fake drugs constitute 30 % of medicines sold in Asia, Africa and Lain America. Pfizer alone lost $2 billion in a year due to counterfeit Viagra.

She then talked about Design Thinking to counter 'Fakes'. Fashion companies like Louis Vuitton and others thought about a great idea – to replicate their fakes and sell as genuine. The fake market is an interesting industry. It's not that the government is not aware of the parallel economy but is reluctant to do anything about it, simply because it's an economy and its adding to the revenues and giving people jobs. The counterfeit industry is global and is $1.2 plus trillion. Therefore, whatever one creates, one has to protect it. That realization came in the 18th and the 19th century when people from Europe started making regulations on how to protect and govern Intellectual Property. The first was the Paris Convention of Intellectual Property in 1883, then an international treaty for protection of Copyrights in 1886 and finally in 1995 the World Trade Organization was formed and it passed an international treaty called as TRIPS for trade related aspects of Intellectual Property Rights which sets the global minimum standards for protecting the Intellectual Property.

Recapitulating regarding the constitution of Intellectual Property - first is the ideation, where an intellectual property is created by ingenuous ideas, which are then translated and transformed into a tangible output. Those ideas must clearly exhibit mental skill and labour. It is necessary to prove, especially when filing patents, to give evidence of the mental skill and labour used in creating a particular idea and invention.

From the Intellectual Property one gets the Intellectual Property Rights which is an umbrella term talking about a bundle of rights that emanate from one single property - Patent or Copyright or Trademark. Fundamentally the rights are broken up into two parts. There are Positive Rights and Negative Rights. The Positive Rights are what one can do with the properties - sell, exploit, commercialize or license it. Negative Rights are also very important and therefore Intellectual Properties are always referred to as exclusive monopoly rights, by which one can exclude anyone from touching one's property. Since monopolies are not good for the marketplace, the monopoly right is time bound.

Ms. Maheshwari then gave a picture of the critical or key Intellectual Property Rights - Patents is a big component, so are Copyrights and Trademarks. Designs is a smaller area and an even smaller area is the one relating to Geographical Indications.

Patents only protects the invention and the idea around that invention for which they are granted and nothing more. Trademark protects one's trade identity, whether in form of a logo or a design or a shape or a word, or alphabets, or numbers. For example, 555 is basically the Trademark of a cigarette. Designs protects the external appearance of goods. Copyrights came in to being when the world began to read and write and when the printing press was invented and communication became a revolution in the lives of humans. Copyright protects only one's expressions.

The easiest classifications of IP are on the basis by which a country governs the IP. There are two methods to govern the IP. One is that the IP is so important and so prevalent in the marketplace that there is a need to create a body of rules and regulations. Thus, there are the Indian Patent Act, Indian Copyrights Act, Trademarks Act, Industrial Designs Act, Geographical Indications Act, Plant Varieties Act, Semiconductors Act and Biodiversities Act. However, all Ips are not protected and recognized by statutes or legislations. There are certain Ips which are recognised as belonging to people and are called as common law IPs. Many times, small time traders in the marketplace exist who often sell something which is quite well known in the marketplace, but which may not be registered. Like in rural markets, one would find that pesticides and insecticides are very often sold by certain prominent names, but those names are not registered Trademarks. For example, Tick Tock 20. They are called as Unregistered Trade Marks. Similarly, many countries have not recognized a Trade Dress - a uniform appearance that a company launches for its brand or for its product. For example, the Trade Dress of Apple is silver and white. Penta purple is the Trade Dress for Cadbury. One of the biggest areas today of common law IPs is Data. There is nothing to say specifically that Data is protected through a particular law; however, the category of Data may fall under any of the statutory IPs.

Trade Secrets and Confidential Agreements or Confidential Information are another area. They involve Technical Know-how, Client Lists, HR Practices of a company, the methods of Raw Materials sources, and India's biggest Intellectual Property source which is Traditional Knowledge. Traditional Knowledge is also a common law IP. It belongs to a community or to the entire country or nation as people.

Patent basically comes from the word 'on the face of it'. Hence, Patented, means it is a public declaration, informing the world that a monopoly right has been granted to a certain inventor. The government rewards the person with a Patent but in exchange the person has to disclose the invention to the government. The Patent gives a 20 years right to a Patentee but after that it comes into the public domain and anyone in the public domain would be free to make or manufacture or copy that invention so that public knowledge is enhanced. It then becomes a benchmark for further innovation. The Patent law is one of the most complex laws and one of the hardest things to be granted is a Patent - the examination process is very long and arduous. There are a number of

criteria, not only by the Government of India but by TRIPS and almost all countries in the world. The criterion is, that the invention should qualify as an invention. Ms. Maheshwari then gave the example of turmeric, whose properties are known in India and have been documented. It's part of a Traditional Knowledge and if someone comes out with a cream and says that it is an antiseptic cream and asks for a Patent for it, one can't get a Patent because that is not an invention, it is Traditional Knowledge. The second is, that the law in India, Section 3 lays down what invention is patentable in India. A global patentability search is done to be able to say that there is no such invention anywhere in the world. For a Patent, one has to prove what one has done to create the invention and the last but not the least prove that it is applicable to human lives, it has some value and that the invention can be reproduced through an industrial process - industrial applicability or utility is the next step of invention.

Trademark is a visual mark, a sign that conveys information. The Trademark should be capable of graphical representation. A Trademark means any device brand, heading, label, ticket, name, signature, words, letter, numerals, shape of goods, their packaging (like in a Trade Dress) or any combination thereof. Today there are unconventional Trademarks like smells, colours, etc. Technically the monopoly right on the Trademark is given for 10 years, however, one can keep renewing it. As a Trademark grows famous like say Surf Excel, it also helps one to advertise one's product. It also assures the consumer of a particular quality.

Copyright, basically has to do with written words. It does not mean the right to copy others work but it is the right to copy one's own work. Thus, as a creator of any work, one has the right to reproduce, amend, revise, put the work out in a different format altogether. When somebody else copies that work then it is called plagiarism. The object of Copyright is to encourage authors, composers, artists, and designers to create original works and to reward them. The areas where Copyright exists are literary works, dramatic works, musical works, cinematographic films, sound recording, computer programs, and the like.

Industrial Designs concerns the external appearance. It is because of designs that companies like Mercedes Benz or BMW or Audi or any famous watch companies or a famous clothes designers are making so the idea of the shape, configuration, pattern, ornament, composition lines of colour are all what are captured in one's design. It should be about the external appearance of an article of manufacture and be aesthetic (ugly designs are not registered); novel and original.

Moving next to Trade Secrets, she said that it is a big area of Intellectual Property as a company's success rides on the Trade Secret. A famous example is that of Coca-Cola whose formula is a Trade Secret. Reverse engineered may have helped bring similar products in the marketplace like Thumbs Up, Pepsi, etc. Nonetheless it is a formula which is a well-kept Trade Secret. Like that there are others - Kentucky Fried Chicken, Listerine etc. A Trade Secret is any "technical or non-technical data, a formula, pattern, compilation, program, device, method technique, drawing, process, financial data, or list of actual or potential customers or suppliers" that is "sufficiently secret to derive economic value, actual or potential from not being generally known to other persons who can obtain economic value from its disclosure or use." A Trade Secret becomes one's Intellectual Property.

Ms. Maheshwari then showed a picture of Nescafe to give an idea of all the kinds of Intellectual Properties riding in that particular one bottle. The picture as a whole is a Copyright. Thus, a whole bunch of IPs are riding on a single bottle.

She then recapitulated the timelines for which Intellectual Properties are alive.

Moving to Organizational Assets, she clarified that every organization has many assets but the one being undervalued and people are not aware about it - the reputation and goodwill; both are extremely difficult to determine. The company's performance could be cyclic or just about average but the share prices could be soaring on rumours on a certain reputation or goodwill that the company has garnered and which becomes the overall Brand of the company. Hence, Brand is both a Trade Mark term as well as a marketing term. Companies like Hindustan Leaver or Unilever have a Brand that need no introduction.

Ms. Maheshwari then discussed about the largest area which is undervalued today – Data, which can be something in terms of content created, in terms of Digital Asset which are tangible assets. Earlier, when companies used to have files and files of data, that was tangible, however, today there are files and files of data stored electronically and that becomes one's Digital Asset.

Intangible Assets rest on two things, one is reputation and the other is recipe. The recipe is the Intellectual Property, whereas reputation is the Brand. For example, the kind of data that platforms like Swiggy and Zomato have. The delivery data that Zomato has could start so many parallel businesses - with the preferences of consumers that they have studied over the years. Most enterprises however, think that to monetize their data they have to sell it, but there are companies like Netflix who do not wish to monetize their Data. They prefer to enrich the cinematic experience of their own consumers. They engage with their consumers and their platform is user friendly and connects with the person in a way that there is a different kind of experience. That's how they build Brand loyalty. They use the Data not only to monetize but to enrich consumer experiences; Telephone companies have a humongous data which they sell to marketeers and marketing companies. Builders and real estate companies have all tied up and they are taking Data from a telephone company. Thus, people and companies are increasing shareholder value by monetizing and protecting their Data.

Talking of the Value of Data and how to value it, she gave the examples of the five of the six biggest companies - Apple, Amazon, Alphabet, Microsoft and Facebook, all in the Data technology business, which are the biggest in terms of Brands by market cap valuation and they leverage it with advanced technologies and thus are able to see continued growth. For example, Google Alphabet which uses GPS navigation and crowdsourced review data about places to improve Google GPS navigation. Innovators use big Data as competitive advantage to introduce efficient practices in the company. E.g., Starbucks. uses Data that's collated to analyse consumer preferences and predict consumer behaviour. A new technique called as Prudent Value Approach for Data valuation has emerged. There are no hard and fast rules in the game, valuation is anybody's guess and these approaches are evaluating intangibles which are very difficult and they would be linked or correlated to what the real business is presently doing, what it did in the past, how it will be doing in the future. Numbers would be ascribed. That is how mergers and acquisitions take place, if a certain brand gets valued by that approach. Many companies, especially in the USA are adopting this approach.

Ms. Maheshwari then talked about some Case Laws. One Case Law was of Zee Telefilms and Sundial Communications relating to data. The latter, a maker of content and cinematic programs was in talks with Zee Telefilms to buy their product called 'Kanhaiyya', which was a concept

only. The pilot was written and submitted to the defendant but suddenly there was no response forth coming from Zee Telefilms and hence then they dropped the idea. Sundial then decided to ask Sony Television to buy their concept. Sony informed them that the film was already being produced by Zee Telefilms. The entire concept and the pilot that was written by Sundial was copied by Zee and Zee was putting out a show which was purely pirated. The judgment went in favour of Sundial.

Another Case Study was of Diljit Titus, a case of a lawyer who was a sole proprietor firm. He had some of his senior associates working with him on a lot of files. Then they kind of crossed and there was tension in the office, so senior associate Alfred A Adebare along with a few others left the firm. While going, they copied a whole lot of stuff that they had worked on and they took it with them. Diljit Titus filed a suit against them saying that that was his copyright and they had no business to take it. The court sided with Diljit Titus and said that it was his Copyright because he was the proprietor and what they did in that company, even though they had done the work, they did it as employees of the company. They had no right to take that work.

Ms. Maheshwari narrated another similar case. The client in Singapore had started a completely new Ed Tech platform to enable students in South Asia and Southeast Asia to get admissions to colleges in USA, on the sports quota. They had hired a person from Delhi, who did good business with them, helped them sort of grow but then suddenly he started playing truant. While leaving the company he took three of the company's candidates. That is when Ms. Maheshwari advised to write to the person and got him to stop his activities. - which was stealing all the data from the company, all client information, methods of doing business. The person got an edge when he started in the market place and was able to get a head start simply by stealing data from his previous employer. Those are the kind of issues that are emerging today with respect to Data, hence, storing the Data and managing it are critical aspects of Valuation of Data.

She gave another example of a case regarding valuing the Trademark of a company. While valuing one needs to look at how efficiently the Trademarks have been managed. The valuation of the Data begins with the owner of the Data, how important the Data is to the company and to the Owner per se and how it is being stored, managed and updated, and how all the legal processes with respect to the upkeep of that Data were being followed.

Ms. Maheshwari went on to discuss the topic called as Leveraging of IPS. If one has the Data, one should know what to do with that and gave the example about Kodak which went from zero to a pinnacle and then came crashing down simply because of mismanagement within the company of their intellectual properties. Kodak, founded 1883 by George Eastman launched. the first camera in 1888 with the slogan 'You press the button, we do the rest". In 1900 they brought out a camera called 'Brownie' priced at one dollar. For 133 years the company was in product development. Now the personal business of the company is owned by UK Pension Fund, because the company had to sell out. That happened because Kodak company had copied a patented product of Polaroid. The battle in court went on for years and Kodak had to pay almost $1 billion in damages to Polaroid. That litigation along with other mistakes which Kodak made cost the company a lot. Later, while the world was moving to digital technology, Kodak did not move fast into the digital space, they failed to adapt to the technological changes and they had to file for bankruptcy in 2012. However, they still own around 7,500 patents but their most invaluable intellectual property is the word 'Kodak'. It is the best Trademark in the world, most valuable and they still hold their brand. The company today concentrates on selling printing equipment and services to businesses.

Next, Ms. Maheshwari gave the example of a very famous, most watched television show on TV – the 'Game of Thrones' based on George R R Martin book called the 'Song of Fire & Ice', which became a sensation in the USA. The eureka moment was when two producers in HBO approached and asked him (Martin) to adapt the book for television. Martin accepted, and the rest is history. HBO reportedly spent $1.46 billion in the making of the 'Game of Thrones' series and in the process, they earned more than twice that in revenues. Today with babies, alcoholic beverages, gaming products, merchandise, everything is named on the HBO 'Game of Thrones' names. She presented a snapshot of what George R R Martin earned from his very fantastic book 'Song of Fire & Ice' and what he earned from HBO and what HBO earned.

Technology Transfer – basically a transfer for which there are various methods. One is the hardcore technology transfer and the other are the methods of licensing around that technology transfer. In the later, the Trademarks related to that technology would also be transferred. The case of Oxford and AstraZeneca for the COVID-19 vaccine was an excellent example. Oxford was the research laboratory and the research was funded by AstraZeneca. The Patent was assigned to AstraZeneca and the researchers of Oxford were named in the Patent as inventors. The Patent was then exclusively licensed to Serum Institute in India to manufacture the vaccine exclusively in India. There's no other institute or any other manufacturer in India to manufacture the vaccine. They would have done that for other countries as well. Supposedly, in case Serum Institute is not able to make that vaccine, then Serum Institute could perhaps sub-license it to another contract manufacturer in India, but everyone has to keep everyone informed. There could thus be a number of players in a particular transaction and it basically refers to the exchange of rights relating to ownership, possession, authority, etc.

Technology Transfer agreements typically relate to acquiring a newly invented product or transferring the methods of the processes or the modalities for production for a particular product, by the necessary goods (raw materials), from the inventor or the licensee or import them, and taking Distributorship for the distribution of the particular product in the domestic and international market. Technologies can be transferred by registered Patents, Copyrights, Utility Models and Designs, In-house Confidential Information, Classified Data, Text Services and support. Computer software and semiconductor chips can also be transferred. It is a business transaction and has two components - a context, a background of that business decision, why A company decides to engage with B company, what is B company's expertise because of which A is engaging with B and then what would be the parameters of the contract. They are all written in a contract. Thus, there is a context and a content which are both captured in the agreement.

Kinds of Technology Transfer: Purchases of equipment, machinery and plants are all examples of technology. The biggest area of transfer of technology contracts comes in the form of licensing contracts. One can license in or one can license out. If one has a technology one can license out. If one has a manufacturing capability but does not have the know-how then one has to license in. That is exactly what the Serum Institute did. It licensed in the technology from AstraZeneca and it is manufacturing the vaccine in India.

Licensing is one of the best ways of technology transfer because it is

any day better than outright sale. Once one goes in for an outright sale one loses the ownership and possession of one's technology but with Licensing one can keep the ownership of the technology; one may lose possession of it but the point is one can engage with multiple players in multiple territories provided of course one has taken Patents in those multiple territories or protected one's Intellectual Property in those multiple territories.

Sale is an outright transfer of one's property but an assignment can be for a limited or an unlimited period of time, albeit for the life of the Intellectual Property. For some purposes relating to his finances a promoter did not want to show that he owned the property or another example where the company was being acquired but the Patent of that company was held in the name of the promoter. The promoter decides to assign the Patent to the company. Thus, the Patent gets transferred from the promoter to that particular company and the company would continue to hold it and at another period of time the company can further assign the Patent to another player or reassign it back to the original player. All these permutation combinations are possible in Technology Transfer.

Joint Venture Agreements: When two separate companies decide to collaborate, they would contract and there would be some amount of equity that would get transferred in a commercial sort of way and the technology is acquired. Franchise agreements happen in this particular way. McDonald's is the biggest example of franchise operations. KFC is another good example. Many famous hotels and restaurants in a particular city or place in India open up outlets all over India that would be a franchise. Starbucks is a wonderful example of franchise operations. An understanding with a franchisee covers both joint venture agreements as well as franchise or distributorship. Distributorship has an advantage – taking McDonald's case she explained that one person took the franchise for entire India and set up outlets all over India by entering into joint venture agreements with different people all over India.

Turnkey Projects: In this case an entire plant and design is taken over as a comprehensive arrangement - end to end, and once it is completed it is handed over.

Those are the kinds of Technology Transfer agreements or the methods of leveraging one's Intellectual Property legally. The terms used for leveraging are licensing, franchising, strategic alliances or partnering, branding, merchandising. For example, Universal Studios or MGM, make their money not only from the films but their Brands. Just like Harry Potter, it's one name but so many different articles were created from that Brand - flying frisbees, leaping frogs as chocolates, different items - pencil box, bags, umbrellas. Every kind of merchandise is riding on those famous Trademarks. The names in the Game of Thrones have become so famous; they have already taken more than 100 registered Trademarks on all those names. Harry Potter have more than 500 registered Trademarks on all the names that have been used in the book and in the films and on all those names, brands have been created and merchandise products have been created.

Another area on which Ms. Maheshwari spoke was on what she has written about, and that is raising bank loans on IP collaterals. It's coming of age, not a very prevalent practice because at the end of the day it is an intangible and banks are not very comfortable with intangibles, though banks do take shares and stocks and one is allowed to mortgage them. However, mortgaging Patent or Copyrights is not heard of but it is picking up everywhere and at least Trademarks, etc. are getting hypothecated in India. People are moving to securitizing one's finances through methods of keeping one's IP in store and raising money on them. Mergers and Acquisitions is one of the best ways of leveraging one's strategies just as some of the companies are collecting Data and how there are people and companies all over the world clamouring to buy that Data.

Talking of a case of Mergers and Acquisitions and IP litigation she said that there are humongous amounts of money being invested in fighting legal battles over IP and the outcome of the legal battles are damages running to billions and billions of dollars. There are many examples. It's an exercise that a company decides to take only after weighing all the options. It's now become another source of revenue for a company.

She gave the example of an IP transaction done in 2014 regarding a company called Osterhout Design Group which was bought over by Microsoft. Osterhout had 81 patents and the price paid by Microsoft was $ 150 million in 2014. Another case was of Global Foundries who bought IBM Microelectronics 16,000 patents for $1,500 million. Apple bought Intel's 17,000 Patents but there is the interesting recent purchase by Microsoft of LinkedIn.- The LinkedIn data, their connections, just like a telephone company's, complete intangible data was bought over. Microsoft paid $26,200 million as the price for buying LinkedIn's data. Another big news was when Amazon bought MGM, the entire stable of 4,000 films, 17,000 hours of TV and multi-million types of data that MGM would be having. All of that Amazon bought for $8,400 million. The question that arises is did Microsoft pay more for LinkedIn? How does one value that Data?

Those are the complex issues that are coming up again and again, all of which involve an IP strategy. Hence, the questions that need to be addressed first – Does one know what one has created? Does one know how to manage it? Does one know what are the rights that have to be protected? It is very important to formulate the Right Strategy for IP in the Boardrooms. It is also important for IP owners to demonstrate to their Board, peers, colleagues and bosses the tangible value of their IP that they have created. One has to demonstrate as to how the market perceives that IP, how the market values it and what is the price that the market is willing to set for the IP. The most efficient way of doing that is to establish an internal licensing program. Every company should have that and they should be able to have mechanisms for setting licensing practices in place. Outsource to third-party licensing organization, sell Patents, leverage Patent pools, find out platforms through which IP brokering can be done and who would help sell one's IP. Those are some of the ways to create the strategy.

With that Ms. Maheshwari put up her last slide to "read out to you something that I love reading out wherever I go"-

"To create something from nothing, in all the natural world is a uniquely human ability. Using our minds we originate works of arts, generate inventions, accumulate knowledge and discover truths about the world we live in. What sets the information age apart from prior periods in history is the price tag we put on these intellectual creations."

- Marlin Bennett in Knowledge Power

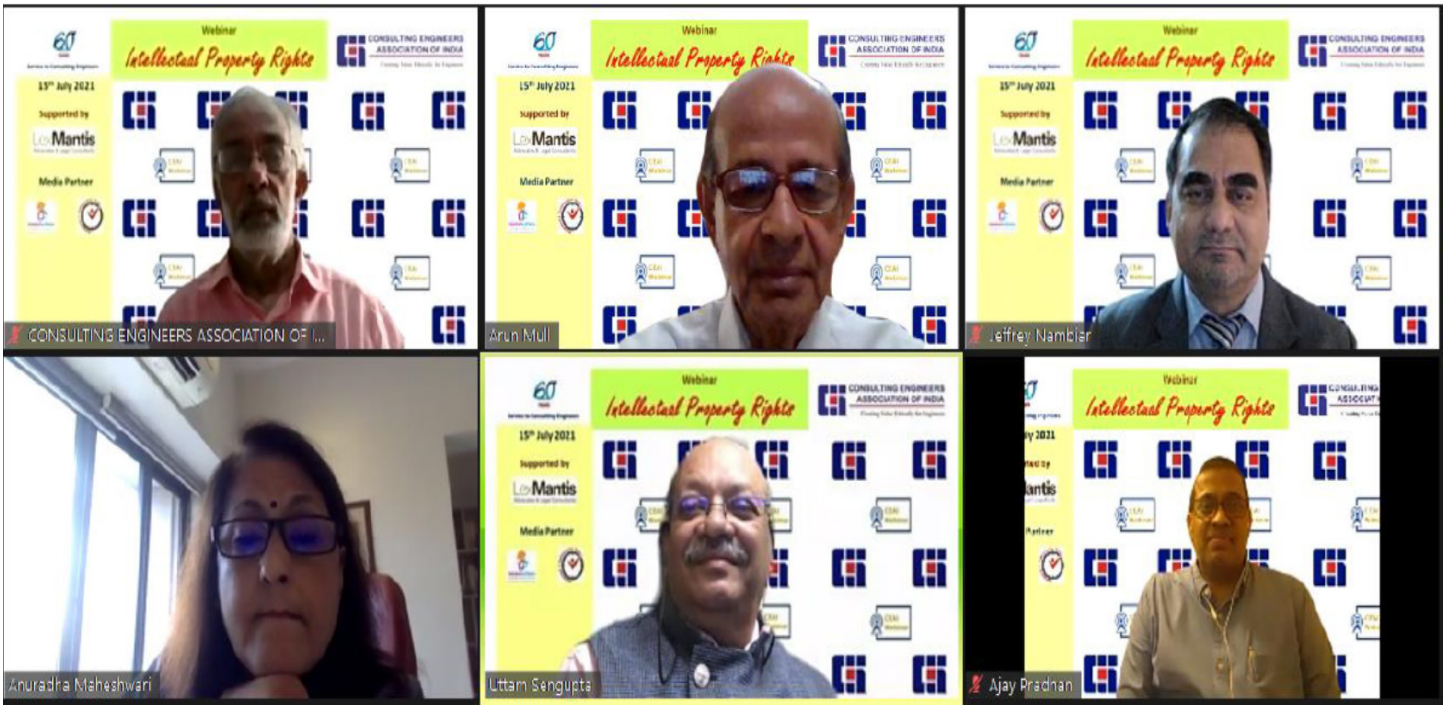
After the presentations, Mr. Uttam Sengupta made his contribution to the discussion and invited participants for their comments and questions. Ms. Anuradha Maheshwari answered all the questions and clarified all the doubts that were raised. Some of the participants also shared their experience of getting IPR for what they had done.

Mr. Jeffrey Nambiar thanked the speaker for driving home the issue of Intellectual Property Rights vis-à-vis the work repertoire of Consulting Engineers and the succinctly explaining all the concepts and requirements with a number of examples. He thanked the participants for their patient hearing and their intensive and extensive interaction through the Q&A, Chat boxes, and online Video and Audio.

The webinar was highly appreciated by all the participants and they were thankful that CEAI had arranged another essential non-engineering topic for their benefit.

CEAI is thankful to the esteemed Speaker Ms. Anuradha Maheshwari who shared her knowledge, experience and expertise on the topic of Intellectual Property Rights; the supporters – Lex Mantis; CEAI's Media partners Management & Communication Group, and Constrofacilitator and the attentive and eager Participants.

Link https://youtu.be/mIND3vsYzDY



WEBINAR ON 'RAISING THE BAR BY WOMEN PROFESSIONALS - 3 CS OF CAREER, CHALLENGES & COMMITMENT'

The Future Leaders Forum (FLF) of CEAI organised a webinar to rekindle the aims & objectives of CEAI in the minds of the younger generation. The theme ***"Raising the Bar by Women Professionals - 3 Cs of Career, Challenges & Commitment"*** was to incite the young engineering fraternity and to promote the talent of next generation of women leaders in the Consulting Engineering Industry. The focus was on hearing from and getting inspired by Young Women Professionals who are ably meeting the challenges by managing their work – life balance i.e., effectively balancing personal and professional lives to meet the challenges of a demanding career. The webinar was held on 30th July 2021.

Ms Neha Jain, Chairperson FLF and the Moderator introduced the theme and invited Dr. Ajay Pradhan, President, CEAI to give his opening address.

Dr. Ajay Pradhan welcomed everyone and thanked the speakers for taking out time for the webinar to share their experiences and learnings. Mr Pradhan also gave a brief about CEAI and the increasing participation and role of women professionals in the engineering industry.

Mr. Prashant Kapila, Vice President CEAI and Member of FIDIC D&I Committee also welcomed the speakers and the attendees and congratulated FLF for organizing the webinar on the very important theme. He explained about the Diversity and Inclusion Committee of FIDIC, its foundation, objectives and its activities.

Four eminent speakers shared their views.

Dr. Elisa Maceratini - Architect and urban planner, working as international consultant in sustainable urban development, highlighted and explained how women as professionals and non-professionals are key actors in building more sustainable, equitable, and inclusive cities.

Harshita Jain- A young entrepreneur working as Director Business Development in Consulting Engineers Group Limited (CEG) focussed her talk on how Women can break the barriers in Engineering.

Parmita Ganguly- Working in power industry as Sr. Manager Instrumentation and Control with TATA Consulting Engineers provided tips and tricks on how women can reach the top of the Organization Chart.

Jeshika Ramchund a Lead Engineer of Developments at Bosch Projects, a consulting engineering firm in Durban, South Africa, currently serving as an Executive Committee Member of FIDIC Africa, Member of FIDIC's Diversity and Inclusivity Committee, Member of the FIDIC Future Leaders Council, and the Chairperson of Consulting Engineers South Africa's (CESA) Gender Diversity Forum, highlighted on strengthening the pipeline of women professionals in engineering.

The Session was followed by Questions from the audience which were very appropriately answered.

The Webinar was concluded with a Vote of Thanks by Neha Jain.

link-: https://www.youtube.com/watch?v=3r80JkFUE2c

WEBINAR ON "CHALLENGES IN ENGINEERING PROJECT DELIVERY WITH FOCUS ON PANDEMIC SITUATION – WAY FORWARD"

The Eastern & North-Eastern Region Centre of CEAI, along with Builders Association of India (BAI), organised a webinar on Saturday, 4th September 2021 on "Challenges in Engineering Project Delivery with Focus on Pandemic Situation – Way Forward". The virtual event started at 4:30 p.m. and ended at 7:00 p.m.

The objective of the webinar was to highlight the challenges faced by the engineering community in delivering engineering projects without sacrificing quality and timely delivery as per the contract. The focus of the deliberations was on the changed scenarios in the infrastructure sector because of the pandemic. Covid-19 posed stiff challenges to the industry not only because of severe supply chain disruptions but also owing to the requirement, at the same time, of resource mobilisation to facilitate the massive investment, in the order of Rs.110 lakh crores, planned for the

infrastructure sector in the next 5 years as part of the fiscal stimulus by the Government of India.
The eminent speakers who provided valuable inputs for the deliberations were:

Speakers

- Mr. R K Pandey, Member (Projects), NHAI
- Mr. Ajit Gulabchand, CMD, Hindustan Construction Company Ltd.
- Mr. Kalyan Ghosh, Head of Transportation, Eptisa India Pvt Ltd
- Mr. Amitabha Datta, Past Chairman, CEAI, E & NE Region Centre

Panelists

- Mr. D P Mathuria, Executive Director (Technical), National Mission for Clean Ganga (NMCG)
- Mr. R P Indoria, Former DG (RD), MoRTH
- Mr. Sushanta Basu, Past President, BAI
- Mr. Amitabha Ghosal, Past President, CEAI

Moderator

Mr. Samiran Sen, Chairman, CEAI, E & NE Region Centre

Presentations

The proceedings were initiated by Dr Ajay Pradhan, President CEAI, welcoming the speakers and panelists and all the participants who took time out to attend the webinar. He spoke briefly on the objective and expressed the hope that significant takeaways would emerge from the programme.

The moderator, Mr. Samiran Sen, then introduced the subject of the webinar and further elaborated on the objective, so as to set the stage for the deliberations to follow. Extracts from the addresses of the speakers and the panelists are presented.

Mr. R K Pandey (representing the Public Sector clients): Mr. Pandey informed that out of the 35,000 km length of National Highways remaining for upgrading under NHDP, contracts for 20,000 km had already been awarded. The present progress of upgrading was 37 km/ day in spite of the land acquisition challenges. As of now, India held the world record for constructing such a large quantum of bituminous/ concrete roads in such a short time. However, the engineering quality and delivery of projects were a matter of concern.

He stated that NHAI had adopted digital technology in a big way. All payments were now being made online within stipulated timelines. Government agencies were extending concessions to bidders, in the pandemic situation, such as reduced performance security requirements and nil bid security. Besides, NHAI had eased approval processes by introducing the concept of 'deemed approval' from authorities within a fixed timeframe and also included built-in Change of Scope (COS) approvals wherever applicable.

Mr. Pandey felt that a Highway Engineer needed to be an all-rounder with knowledge of social, environmental, financial aspects of the projects besides engineering. Traffic Projections, a perennial source of dispute, were being subjected to closer scrutiny before financial closure. Dispute redressal mechanism was being streamlined by DRB process with equitable clauses in contracts.

Mr. Ajit Gulabchand (representing the construction industry): Mr. Gulabchand, was quite forthright in his views about what he called 'pain points' troubling the construction industry. He believed that the ambitious investment plan was bound to be hampered by the capacity constraints in all the players.

Delayed payments by the clients were a major issue that was creating cash flow problems leading to rise in the cost of borrowing. He stated that the high cost of guarantees had to be brought down from 25-40% to 5-10% to increase the competitiveness in the market. The conditions of contract were still biased towards the client. BGs were being encashed without proper justification. He emphasized that the risk of financing could not be passed on to the Contractor. There was clearly a trust deficit between the parties. He felt that the views of the Engineer (Consultant) must be given due importance to avoid unnecessary disputes.

Mr. Gulabchand made a few valid suggestions such as:

- General Conditions of Contract needed to be more equitable, particularly for EPC and BOT projects
- Mobilisation advance should be a line item not requiring any BG
- Global borrowing from bond markets should be permitted for long term funds
- The liabilities of all parties must be restricted to the project cost

Mr. Kalyan Ghosh ***(representing the consulting engineers):*** Mr. Ghosh made a detailed presentation explaining the different stages of project preparation undertaken by consultants in highway projects culminating in, primarily to, Feasibility Study Report (FSR) and Detailed Project Report (DPR). He flagged the serious issues which were creating problems at various stages of the activities and hindering timely project delivery:

- Unrealistic timelines for preparation of FSR/ DPR
- Delay in payment which was upsetting cash flow
- LA activities involved steps where the private sector consultant had to deal with Revenue Departments without proper authority. Decisions regarding alignments and other improvement proposals were late in coming.
- RFP/ TOR was, in many cases, not suited for the project in question, thus bidding and pricing were found to be difficult
- Award of project to generally least cost bidders resulted in poor quality of work/ deliverables
- The Client was not addressing the Consultant's genuine problems.

As far as the role of the Consultant as Design Director of the EPC

Contractors was concerned, Mr. Kalyan Ghosh highlighted the following problems:

• Change of alignment due to LA difficulty, introduction of additional structures, etc. or actual requirement due to time gap between DPR and award of work resulted in deviation from the original scope of work.

• Delayed surveys disrupted all further planning.

• Payments were usually delayed and not in keeping with the progress of work.

• Delay/ dispute of LA, forest clearances and environmental clearances severely affected design work progress

• Delay in giving approval of Change of Scope.

Mr. Amitabha Datta (representing the Consultants): Vastly experienced in managing PMC assignments, Mr. Datta spoke about the circumstances which were commonly causing difficulties to Consultants in performing adequately as the FIDIC-Engineer or as the Authority/Independent Engineer. He spelt out some of the major issues hindering service delivery:

• Delayed appointment of Consultants - leading to problem of retention of Key Professionals

• Inadequate time allocation to Contractors in a Contract – frequent EOT requirement and, hence, wastage of professional resource.

• Delay in according approvals of various submissions

• Delay In Payment

• Issues related to providing encumbrance-free land to Contractors and Consultant's involvement

• Need for strong functioning of the authority for externally funded projects (ADB/ WB/ JICA, etc.) through PMU and PIU.

Mr. Datta made out a strong case for delinking the Consultant's contract duration from that of the Contractor's. He suggested formation of a monitoring team consisting of representatives from all the stakeholders. He believed that the Clients were over-structured in terms of capacity.

Mr. D P Mathuria (representing Water Resources sector): Mr. Mathuria, spoke from the perspective of River System sector. He informed about the on-going Namami Gange programme of Government of India which aimed at rejuvenation of River Ganga from its source to the sea, covering several states. Besides cleaning up the river itself, the main component of the programme was introduction/ construction ID drainage system, at a cost of Rs 20,000 crores, to prevent industrial pollutants from entering the river. Already 330 projects were underway and majority of them were nearing completion. He stated that rapid urbanisation was a major issue and preservations of river systems and water bodies was imperative. Mr. Mathuria also believed that the performance of a few Consultants was less than satisfactory.

The eminent panelists who shared their views were:

Mr. R P Indoria, advocated adoption of FIDIC form of contracts but with the rider that the COPA should not modify the GCC to such an extent that the spirit of the latter gets vitiated. He also stressed on a prompt and fair dispute redressal system like DAB.

Mr. Sushanta Basu, reiterated that, because of the ongoing pandemic situation in the world and the resultant disruption, the construction industry in the country was in tatters. While the work volume decreased appreciably, the indirect expenses including salary and wages, bank interests, etc remained constant. Unless, Governments came forward with an open mind to mitigate the problems by sharing the expenses, it would be extremely difficult to face the challenge of 5 trillion USD. For instance, the end user (in this case the Client) had to bear the burden of GST and it should be so even during a force majeure condition including assuming the burden of extra expenses of the construction projects.

Mr. Amitabha Ghoshal, pointed out that totally unpredictable situations like pandemic and the increasing occurrence of natural hazards like super-cyclones, flooding, and sustained drought situations warranted that the contract documents provide for monetary compensations in addition to provisions of EOT in force majeure situations. FIDIC contracts needed to incorporate such provision for a start. Clauses should be introduced in the selection criteria for Consultants and Contractors to initiate the same and this new paradigm should be introduced across the world, with FIDIC taking the lead.

Mr. Sen, the Moderator, concluded the proceedings by affirming the following takeaways:

• All parties and stakeholders must work in the spirit of partnership rather than in competition/ conflict. Trust deficit among the parties was a serious impediment and must be removed.

• Payments terms must ensure satisfactory cash flow.

• Contract terms and conditions must be specific and equitable.

• Need for capacity building of Consultants and Contractors as well as that of the Client was imperative and immediate.

• Specialised consultants (engineering/ environmental/ LA) should be allowed to work as consortium/ JV at project preparation stage for best results.

• Dispute adjudication mechanism in line with FIDIC was needed for speedy and fair resolution of disputes during the project duration itself.

• External borrowing must be made easy to fund long term needs of the builders

• A monitoring committee with representatives from all stakeholders should be established to facilitate smooth implementation of large projects.

The webinar ended with a vote of thanks to all the attendees and participants, who numbered nearly a hundred. He also thanked the speakers and the panellists for sharing their views.

Link-: https://www.youtube.com/watch?v=MSoiKKGJljo

WEBINAR ON "EMPOWERING MSMEs FOR GROWTH"

Consulting Engineers Association of India (CEAI) through its Western Region Centre organized a webinar on another 'non-engineering topic', a business-related theme - "Empowering MSMEs for Growth" to help small professional firms to grow their business and contribute to the Nation's prosperity. The webinar held on 15th September 2021, delineated the schemes by the Government of India to help the Service Sector grow and the measures initiated to provide the necessary impetus for making the Micro, Small and Medium Enterprises (MSME's) a stronghold for nurturing the country's economy so that the MSMEs become a major centre for India's exports.

Mr. Uttam Sengupta, Past Chairman CEAI-WRC, Mr. A P Mull, Past President CEAI, Dr. Harshavardhan Subbarao, Chairman CEAI-WRC, Mr. Jeffrey Nambiar, Hon. Secretary and Treasurer, CEAI-Western Region Centre (CEAI-WRC) and Mr. Rajat Taimni, Member Core Committee CEAI-WRC organised the webinar.

Mr. Uttam Sengupta introduced the topic of the webinar and then requested Dr. Ajay Pradhan, President CEAI to give his opening remarks.

Dr. Ajay Pradhan heartily welcomed all and stressed on the need of the small engineering firms to be aware of and benefit from the number of schemes introduced by the Government of India. He also informed the audience about CEAI as being the representative body of the Consulting Engineers and a Member Association of FIDIC in India.

Mr. Uttam Sengupta thanked Dr. Pradhan for emphasising on the educative need of the webinar so that small consulting firms could become aware of the facilities available. He introduced Ms. Parineeta Pandhram, Assistant Director at MSME-Development Institute, Ministry of MSME, Government of India at Mumbai and requested her to inform of the schemes of the Government of India.

Ms. Parineeta Pandhram presented the various ***"Schemes of the Government of India to assist MSMEs".*** She informed that The Micro, Small and Medium Enterprises Development Act (MSMED Act) was notified in 2006. As per the Act an "enterprise" means an industrial undertaking or a business concern or any other establishment, by whatever name called, engaged in the manufacture or production of goods, in any manner, pertaining to any industry specified in the First Schedule to the Industries (Development and Regulation) Act, 1951 (55 of 1951) or engaged in providing or rendering of any service or services. Thus, an Enterprise is a company, especially one involved in Manufacturing or rendering Services for making profit. The revised classification of Enterprises makes no difference between Manufacturing and Services.

From July 01, 2020, an MSME (Micro Small and Medium Enterprises) is known as Udyam, and the requirements for Udyam registration and the process for registration were explained. Wholesale and Retail trading activities are also now covered under NIC Codes 45, 46, & 47 and they can register afresh in Udyam Registration. There are sub-categories under the Codes.

Composite Criteria: Investment and Annual Turnover			
Classification	Micro	Small	Medium
Manufacturing & Services	Investments < Rs. 1 cr. and Turnover < Rs. 5 cr	Investments < Rs. 10 cr. and Turnover < Rs. 50 cr	Investments < Rs. 50 cr and Turnover < Rs. 250 cr

A provision had been incorporated for Delayed Payments to MSMEs by which the buyer is liable to pay compound interest to any MSME supplier.

The different Schemes and Services of Ministry of MSME were presented. MSME-DI provides Project Consultancy services and serves as a one stop solution for prospective entrepreneurs on 'How to Start Enterprises' and 'How to expand the business' for existing entrepreneurs. They also help in Entrepreneurship and Skill Development Trainings. Marketing Support is also provided under Government e-Marketing. For that the enterprise has to register as a Seller with the Government e Marketplace (GeM). Ms. Parineeta showed the success stories and fairs arranged by the MSME-DI, Nagpur.

Talking of Credit facilitation, she explained about Interest Subvention and the Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) schemes. Next she mentioned the Prime Minister's Employment Generation Programme (PMEGP)' which was launched in 2008 by merging of the then existing Prime Minister Rojgar Yojana (PMRY) and Rural Employment Generation Programme (REGP) schemes of the Ministry.

She also explained the Pradhan Mantri MUDRA Yojana (PMMY) and the salient categories under it: Champions Portal - Creation and Harmonious Application of Modern Processes for Increasing the Output and National Strength (CHAMPIONS); Technology & Quality Up gradation schemes; Credit Linked Capital Subsidy Scheme (CLCSS); Lean Manufacturing Competitiveness Programme (LMCP); Intellectual Property Rights; Business Incubation; and, ZED certification scheme Zero Defect – Zero Effect. She also dealt with MSME Business Incubator for converting innovators to companies; MSME Technology Centers - MSME Tool Rooms which act as Center of Technology-Transfer to assist SMEs, in the fields of Design and Manufacture using Latest Technology, Skill Development, and Consultancy. She showed a 3D Product Gallery and then talked of the Skill Development Areas in which the MSME-DI can assist.

Regarding Export Promotion by Ministry of MSME, she said that they provide Assistance for Export Promotion (Export Facilitation Cell), International Co-operation (IC) Scheme and Export Promotion through SEZ.

MSME-DI are working towards fulfilling the vision of Atmanirbhar Bharat. There were a number of schemes under that.

Ms. Parineeta then explained the Cluster Development Scheme. Cluster being defined as "Concentrations of inter-connected enterprises and associated institutions that face common challenges and opportunities", whose objectives are to Support sustainability of MSMEs by addressing common issues; Capacity Building of MSMEs for common supportive action; Create/ upgrade Infrastructural Facilities in Industrial Estates/ Clusters; Create/ upgrade Infrastructural Facilities in Industrial Estates/ Clusters; and Promotion of Green & Sustainable Manufacturing Technologies.

Mr. Uttam Sengupta thanked Ms. Parineeta Pandhram for explaining the various schemes of the Government for MSMEs. He then introduced Ms. Latha T, Former MD& CEO Dhanlaxmi Bank Ltd. and General Manager (Retd) Punjab National Bank and requested her to make her presentation. Ms. Latha made a presentation on "MSMEs – Importance, Finance, Policies, Funding, Risk & Management Strategies". Setting the scene, she informed that MSMEs are the backbone of Indian economy and have been creating jobs - 11.10 crore jobs in over 6 crore units. Their share in GDP growth was around 8% and around 30% in Exports. The contribution of manufacturing MSMEs to Gross Value Output was about 33%. They are thus quintessential part of India's economy. The new definition had already been elaborated by the earlier speaker, however, she clarified that the export related Turnover would not be counted in the limits of Turnover for any category of MSME units. The MSME sector has easy access to raw materials and labour, etc. and the government is promoting and supporting them. They require smaller capital to set up but man power training is required. The initiatives of Atmanirbhar Bharat Abhiyaan and Vocal for Local would help them. The amendment to the IBC code of increasing the default amount for filing to minimum Rs. 1 crore is a boon but also a bane.

The Atmanirbhar Bharat Abhiyaan introduced 6 reforms to revive the MSME sector viz. Rs 3 lakh crore collateral free Automatic loans as Emergency Credit Line Scheme (ECLGS) for COVID relief; Rs 20,000 crore subordinated debts for MSMEs; Rs 50,000 crore equity infusion through MSME Funds; New Definition of MSME; Global tender to be disallowed upto Rs 200 crores; and Other interventions for MSMEs. Under the Production Linked Incentive scheme, announced in March 2020, new industries and sectors were announced; and, the minimum incremental investment for MSMEs has been made Rs. 10 cr.

Vocal for Local and Ubharte Sitaare have also been introduced. The main features being an alternate investment fund with Rs 250 cr corpus; Aimed at identifying export oriented units with technological, product or process advantages in their sectors and supporting them with funding and advisory services to accelerate their growth; Factoring Regulation (Amendment) Bill 2021 drastically increases number of firms that can provide MSMEs with funds against Trade Receivables; 20% of procurement of Central Ministries, Departments and Public Sector Undertakings to be from MSMEs; and MSMEs with a turnover upto Rs 5 cr would be permitted to self-certify their GST returns (CBIC) instead of CA certified certificate.

Udyam Registration helps to acquire Government tenders easily since it is integrated with Government's e-Marketplace and various State Governments; Concessions are available for setting up an industry; Allows credit for MAT for upto 15 years instead of 10 years; Rate of

Interest on Bank loans will be more attractive; however, Enterprises having UAM will have to migrate before 31-12-2021 to Udyam.

Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) was launched to strengthen credit deliver system and to facilitate flow of credit to the MSE sector, create access to the finance for unserves, underserved and under privileged. Ms. Latha explained the salient features of CGTMSE.

Explaining the Ease of doing business for MSMEs, she stressed that eventually, many small businesses and emerging brands have to shift their business to E- commerce market placed to crack key metrics for rapid growth; she gave the example of BabyPro, Kolkata. Although Udyam Registration and registering under Startup India do provide certain benefits but regulatory bottlenecks are still continuing to be a challenge.
Funding opportunities for MSME: MSME come under Priority sector lending by financial institutions. Specific targets allocated to banks and large number of specialized branches opened for serving the said sector. Different kinds of fund available for this sector. These can be divided mainly into a) Fund based and Non fund based Working Capital limits, and, b) Term loans for new projects/ expansion.

Trade Finance is by way of a Letter of Credit which can be Sight/ Demand LC or Usance LC. The advantage of Usance LC is availability of time period to make the payment. In case of Import or Export Letters of Credit, it is better to take forward cover to hedge the risk of currency fluctuation. Banks/ Financial Institutions normally advise the customer for a minimum percentage of hedging unless the customer has natural hedge in their business activity. SBLC - Standby Letter of Credit are irrevocable agreements for the payment of money. They function like guarantees or obligations and are provided by the bank for the benefit of the beneficiary. She explained how the Funding for MSMEs is assessed by banks and what the Small Industries Development Bank of India (SIDBI) and National Small Industries Corporation Ltd. (NSIC) provide. She explained Trade Receivables Discounting System (TReDS) and the main steps that take place during financing/ discounting through TReDS. She then explained Factoring.

Pre-Packaged Plan for MSMEs: The President of India promulgated the Insolvency and Bankruptcy Code (Amendment) Ordinance 2021 on 4th April 2021. The Pre-Packaged Plan initiative was based on a trust model and the amendments honour the MSME owners by trying to ensure that the resolution happens and the company remains with them. It is expected to alleviate the distress faced by MSMEs due to impact of pandemic. It is timely, efficient and cost effective resolution, and sends positive signal to debt market, employment preservation, ease of doing business and preservation of enterprise capital, and assured continuity of business operations for Corporate Debtor (CD); less process costs and maximum asset realization for Financial Creditors (FC); Assurance of continued business relations with corporate debtor and rights protection for operational creditors; In this the borrower/ Corporate debtor have to submit a Base Resolution Plan to the Resolution Professional, etc.
Restructuring for MSMEs: RBI on 6th August, 2020 provided a fresh lifeline to millions of stressed small businesses by extending the provisions of restructuring norms.
Resolution Framework as per K V Kamath Committee provide for resolution only to borrowers having stress on account of COVID 19 as per the guidelines laid down by the Committee.

Risk Assessment & Management Strategies: The Banks/ Financial Institution check the credibility and credit score of the borrower. Credit Score is from CIBIL and Equifax and may ask the company to get rated from a rating agency authorized by RBI; ECGC Cover for exporters; and Forex /derivatives/ hedging.

Risk Mitigation: due to resource limitations, the MSME enterprises are typically very fragile, with high-risk liability, which makes them vulnerable even to the smallest tremors of instability in the business ecosystem. The only way to counter these threats is to develop a risk-resilient organisation, by leveraging Enterprise Risk Management (ERM) to safeguard against economic instability, natural disasters, and cyber risks. ERM should be a mandatory process for MSMEs, in order to improve their chances of sustained and successful longevity. ERM plays a key role in protecting the assets and resources of an organisation, ensuring that risks are reduced to an acceptable, reasonable, and manageable level.
Challenges for MSMEs: They have often struggled to grow due to lack of timely financing; High cost of credit especially for innovation driven units; Lower Technology levels- upgradation required in inter connection of products, business models & value chains, artificial intelligence, simulation, sensor based technology, etc. a must in today's system; Insufficient infrastructure facilities: Profitability and productivity of MSMEs affected due to lack of good roads, water, power, etc.; Delays in settlement - Due to limited bargaining power of MSMEs in the market, the large scale buyers usually have long settlement lead time when they deal with big corporates; and Effects on the Cash Flow of the unit. Actual credit period is 14 days but invariably there is a long delay. During FY 2020-2021, Government of India made units settle the payments to MSMEs.

Vision set by Government of India: It includes facilities one of which is by the impetus to Make In India as Production Linked Incentive (PLI) which is only for manufacturing companies registered in India.

Service Sectors – The Government of India is looking beyond the Software sector since the Service sector contributes 40% to India's Exports and accounts for 54% of the economy according to the Economic Survey 2020-2021. The intent is to make India a Repair Hub - an outsourcing hub for Electronics Repair Services with India's enviable Tech force; Hospitality and Tourism boost, plus Medical Tourism are the other areas.
While concluding Ms. Latha reiterated that MSMEs are the growth engines, propelling job creation, urbanization, higher education, and improving the quality of life of the people. They should make use of the benefits offered by the Government and contribute their best to enable the country to realise its ambitious goals of **Make in India** and **Self-Reliant India** through the development of goods and services to substitute the imported goods and services and to improve export performances. MSME's also need to maintain efficiency in cost, upgradation of products with changing needs of customer, for their success. All those were MSMEs; and MSMEs with a turnover upto Rs 5 cr would be permitted to self-certify their GST returns (CBIC) instead of CA certified certificate.

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Mr. Uttam Sengupta thanked Ms. Latha for the educative lecture highlighting all the key aspects and requested Mr. Jeffrey Nambiar to invite participants for their comments and questions. Ms. Latha and Ms.

Parineeta Pandhram satisfactorily clarified all the queries raised.

Mr. A P Mull said that the deliberations were very informative and covered the entire gamut of the MSMEs schemes. It was upto the consulting engineers to go deep into the matter and see how they could raise their

bar. In doing that that must do it ethically. They are engineers and ethics must be on top of their mind, and like Ms. Latha had cautioned, without sacrificing Quality; that must be paramount. For Engineers, engineering with technical excellence has to be a MUST. All the rest would follow, if they stick to those two.

Mr. Jeffrey Nambiar thanked the speakers and the participants for the extensive coverage of their topics and the dialogue with the audience. He also thanked the President CEAI and the CEAI Secretariat for all the help.
The webinar was appreciated by all the participants and they were thankful that CEAI had been arranging essential non-engineering topics for the educating the service providers.

CEAI is thankful to the esteemed Speakers Ms. Latha T and Ms. Parineeta Pandhram; CEAI's Media partners Management & Communication Group, and Constrofacilitator and the all-important event partners - the participating Audience.

Link https://youtu.be/LUEACksttTs

WEBINAR ON "GREEN ENERGY TRANSITION FOR SUSTAINABLE FUTURE"

Southern Regional Chapter of CEAI conducted their maiden webinar on "Green Energy Transition for Sustainable Future" on Friday, 17th September 2021.

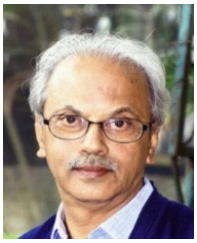
Welcoming everyone, **Dr. Ajay Pradhan** President CEAI spoke about the global developments and opined that India could emerge as an innovation hub for a global green shift with supportive policy action.

Dr. Rajashekhar Malur, Member of the Governing Council, CEAI and Chairperson, Southern Region Centre, was the Moderator. He presented the Sustainable Development Goals; the projected power generation mix globally and in India by 2050 and highlighted how Digitalisation enables Energy Transition.

Sustainable infrastructure or Green Infrastructure systems are those that are planned, designed, constructed, operated and decommissioned in a manner that ensures economic and financial, social, environmental (including climate resilience), and institutional sustainability over the entire infrastructure lifecycle

(International Good Practice Principles For Sustainable Infrastructure – UNEP).

Presentations were made in four key areas of Energy Transition by Expert speakers.



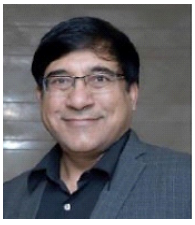
Dr. Ajit Sabnis, Sustainability Expert and Past President – Association of Consulting Civil Engineers, spoke on ***"Green Infrastructure"*** focusing on circular construction, mitigation strategies for decarbonization, critical design parameters for implementation, and on technology integration for built environment.

Sustainable Cities are those that are Economically Productive, Socially Inclusive, Environmentally Stable and Resilient to Eco-Shocks and have a Seamless Integration with Nature, i.e., nature itself as Infrastructure. Key features of a sustainable city are: Resources and services in the city are accessible to all; Public transport as alternative to private vehicles; Walking and cycling lanes; Safe open areas; Renewable Energies; Waste Management; Energy efficient Infrastructure; Affordable Housing; Cultural Integrity; Water Conservation and Water Management; IOT/ Technologies/ Network and Geo-specific disaster management.

Infrastructure development decisions should be based on strategic planning that is aligned with global sustainable development agendas and supported by enabling policies, regulations and institutions that facilitate coordination across departments at both national and sub-national levels of government and public administration. The basic design philosophy of sustainable infrastructure is that it does not follow the linear construction approach of Take-Make-Use-Dispose but a circular construction approach in which the products and assets are designed and built to be more durable, refurbished, reused and disassembled. Buildings are seen as 'Material Banks', and once the use in a particular building is over, the same material can be taken out and used in a different building.

It is to be noted that the next 40 to 50 years are already 'locked in' as a result of past GHG emissions. In order to mitigate this, the Design Life needs to be looked at for 40 to 100 years for new designs. Decarbonisation strategy should involve energy efficiency, clean energy and low carbon approaches. That makes climate change a current issue rather than a future issue. It is critical for infrastructure to cope with climate change. The mitigation strategy of Adaptation involves Risk Assessment and Disaster Management; Avoidance of actions that create difficulty for critical infrastructure to cope with climate change; Enforcement of building regulations and Sustainable construction practices; Protection of ecosystems and natural buffers; Installation of early warning systems; and, Holding regular public preparedness drills and Working in partnership with communities and Reviewing those adaptation strategy actions regularly. The Mitigation strategy of Sustainable Assessment that leads to Sustainable development involves measurement of Embedded Energies, Material Suitability, Material Classification, Building Classification, Building Clusters Classification and Larger Community/ Society through Sustainability Indices. The mitigation strategy of Decarbonization involves Adoption of measures to reduce fossil fuel burning; Increasing carbon sinks and reducing deforestation; Controlling population and urban migration; Improving energy efficiency and using clean energy; and Shift from fossil fuel to renewable energy. There was a need to Re-engineer high energy materials to low carbon economy, introduce smart grids and improve power transmission; increase recyclability and reuse and also to Manage waste smartly.

The 'Ten Principles of Implementation' are: Long-term planning and cross - sectoral alignment; Needs-based, integrated, flexible, and resilient; Assess sustainability early; consider cumulative impacts over lifespan; Minimize environmental impacts and invest in natural infrastructure; Design for circularity and resource efficiency; Balance between social and economic infrastructure; make it inclusive; Create jobs and support local economies to maximize economic benefits; Ensure fiscal transparency, financial integrity, and debt sustainability; Transparent decision-making, inclusive of public participation; and, Use data-driven approaches. The technologies that help us are Low energy buildings; Precast, PEB, monolithic and modular construction; High-rise buildings; Building automation; Passive architecture; Economic buildings; 3D Printing; Drones; IoT; Sustainability assessment and Green rating systems; BIM, AI and Industry 4.0.



Mr. Mangal Dev, Director, Hitachi India Private Ltd. (Region) & Head, Railway Systems Business, India & South Asia (BU), spoke on ***"Green Transportation"*** focusing on Hitachi's strategy for MaaS (Mobility as a Service) for sustainable travel and HYBARI (Hydrogen hybrid advanced rail) with a thrust of digital technologies and intelligent transportation.

Hitachi aims at providing Mobility Solutions with Social, Environmental and Economic Values by integrating them through the digital platform called LUMADA. It is committed to the environment with multiple partners and has set a goal of 80% reduction in CO2 by 2050. Elements for achieving the overall goal of cleaner and greener planet are a plethora of Smart solutions for Governance & Education, Health Care, Buildings, Energy, Agriculture, Infrastructure, Technology, Citizens and Transportation and for all of these, the user would also be educated. Hitachi calls this Social Innovation Business.

Social Innovation involves reducing carbon, and improving lives with Green Mobility, centered on maximizing Wind farms connections and reducing cost of low carbon Hydrogen; making the switch to zero emission vehicles

simpler; unlocking discontinuous electrification on non-electrified routes; Optimising shipping routes using AI; Utilising AI and machine learning to improve processes in industry and public sector, integrating renewable technologies and greening buildings; and Innovating across energy the system and getting electricity where it is needed; and prioritising the delivery of digital solutions that improve and optimize the whole transport system. The whole-system approach leads to sustainable and affordable travel with convenience. The synergy between Trains and Electric Vehicles needs to be increased via a holistic systems approach, optimization and focus on 'Mobility as a Service' – that is crucial for net zero carbon. Battery technology is crucial for the success. The common aim amongst all the areas in which Hitachi is present is to provide seamless travel and thus 'Mobility as a Service' is a modal shift in the transport system to provide sustainable travel with least cost.

Hitachi is a Principal Partner for COP26 as Climate Change Innovator. Its target is to become carbon neutral in its offices and factories and amongst other targets to showcase green Mobility to the world through multi-modal mobility by focusing on R&D, Energy Management and H2 related technologies. Talking of the Rail sector he said that there are hybrid trains, zero-emission battery trams, replacing diesel engines with batteries to achieve net zero railways by 2035/2040. The whole transport system needs to be optimized with emphasis on railways.

Mr. Dev also introduced HYBARI HYdrogen-HYBrid Advanced Rail vehicle for Innovation which is through combining the railway and automotive technologies to adapt fuel cells used in automobiles for railway applications. The testing for this is scheduled to start in March 2022. He further spoke on digital solutions that improve and optimize the whole transport system. MaaS is by connecting multi-modal travel experience through digital platforms beyond rail to include other modes of transport such as busses, eBuses, eVehicles, eBikes, Parking, Highways Tolls to enhance passenger experience.

He concluded with a discussion on Intelligent Electric Vehicle Fleet Decarbonisation, HVDC, and building a flexible energy infrastructure to cater to increasing renewables on the grid.

Mr. Atul Choudhari, Chief Technology Officer, Tata Consulting Engineers

discussed on ***"Green Processes"*** and spoke about the principles of Green Chemistry, various biofuels and the Reduce – Reuse – Recycle philosophy for a Circular Process Economy. In response to climate change, the scientific community is being challenged to find sustainable technological solutions to help in controlling global warming. Several industrial chemical processes were invented way back when the "Green" process was not the priority. Those traditional routes and pathways are no more sustainable in the long run. In that context the concept of "Green Chemistry" would address several options to minimise the adverse environmental or health impacts from the chemical manufacturing process. The prime objective of green chemistry is to select the safest and most efficient pathway to manufacture the chemicals while reducing waste.
Some of the green process technologies such as biofuels, biogas, bioplastics could be made from renewable sources such as edible and non-edible biomass or from Algae. Those biofuels offer alternate low carbon solutions to the present fossil fuel-based extraction of fuels. Though the costs remain a major concern for mass scale deployment, the scientific community was continuously upgrading the technologies for faster and feasible implementation.

Hydrogen finds tremendous potential as an alternate source of energy as it can be produced in a green way by using renewable energy. Besides the existing applications of ammonia or methanol manufacturing, hydrogen finds new users such as Transportation fuel, Stationary power generation, and Combustion fuel. Industrial ammonia production emits more CO2 than any other chemical making reaction. Life Cycle emissions from current methanol making process account for roughly 10% of the total chemical sector emissions. Ammonia and methanol can be produced through green chemistry pathways. Ammonia was also being looked as potential candidate for hydrogen energy carrier. Hard to abate sectors such as steel were relying on use of green hydrogen in the DRI process.
Thus, the overall approach should consider implementation of Green Processes followed by Reduce-Reuse-Recycle mantra. With the global population projected to grow by 25% till 2050, the energy demands would increase by 40% in the same period. Climate change targets call for reduction in Total Energy per GDP by around ~35% on a global basis. In short, as the population grows, one must continue to drive GDP growth; and for that one would need more energy. However, one must do it following the moto 'more with less'.

Mr. Vaibhav Agwan, Vice President, Siemens discussed on ***"Green Technologies"*** with focus on Hydrogen vouching

strongly for PEM (Proton Exchange Membrane) technology, sector coupling as a key lever for green technologies and challenges on using Hydrogen in Gas Turbines. The green technology landscape of the future would have multiple elements, some of which may not even be known today. Any technology which has widespread geographical availability, penetrates multiple sectors and be available at affordable costs would be sustainable. Among the technologies of the future, hydrogen has the potential to act as a new secondary energy carrier satisfying all of the requirements for electrical generation, mobility and industrial sectors.

In order to supply the new hydrogen economy, there would be an increased usage of water electrolysis technology to produce hydrogen. The energy for electrolysis would come from renewable sources. An electrolysis technology that supports volatility of renewables, provides high purity of hydrogen at lower total cost of ownership would replace all other technologies. Out of the set of technologies available today at commercial scale, PEM technology looks very promising. However, the transition to commercial scale green technologies would be gradual due to affordability and availability reasons. However, it would require intermediate methods to decarbonize. For example, in power generation, an intermediate step could be replacing coal with gas, and then as the hydrogen economy scales up there could be subsequent modifications in gas turbines to accept higher percentage of hydrogen. What one can be certain of is that Hydrogen would play some role in accelerating decarbonization.

Dr. Malur, recapitulated the four interesting sessions and moved to the Q&A session in which the speakers gave their views on the numerous queries raised by the audience. At the end he thanked all the expert speakers for their efforts in delivering the very interesting lectures on the transition to green energy and responding to the participants.

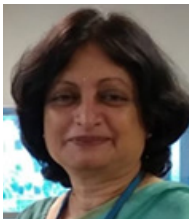
The Vote of Thanks was delivered by Mr Moorthy M R, Member of the Governing Council, CEAI.

CEAI records it gratitude to PEM Technologies for sponsoring the event and the CEAI Secretariat for the support in conducting the webinar.

Link: https://youtu.be/umDW5r1oLsY

WEBINAR ON "ETHICAL CONDUCT IN ENGINEERING CONSULTANCY PRACTICE'

To create an awareness about ethics in the profession and to promote it, CEAI organized a Webinar on ***"Ethical Conduct in Engineering Consultancy Practice"*** on 24th September 2021.



Ms. Sayona Philip, Chairperson of CEAI Ethics & Quality Committee was the Moderator and introduced the theme of the webinar.

Dr Ajay Pradhan, President CEAI welcomed the dignitaries and participants and spoke of his views on the theme of the webinar.

Mr Richard Stump, Chair – Integrity Management Committee, FIDIC, gave the keynote address. He spoke on the theme ***"Collective Action - An Integrity Challenge"***. He focused on the need for a firm adherence to an ethical code of moral or artistic values – incorruptibility being the key; the importance of the quality of having strong ethical or moral principles and following them at all times, regardless of who was watching. He said that he had studied the CEAI's Code of Ethics and felt the point relating to 'Endeavour to provide opportunity for the professional development and advancement of professionals in his/her employment' suggested the need and provided *an opportunity for Collective Integrity.*

He spoke on the importance of collective action with collective integrity and gave the wonderful analogy of the forest ecosystem and the necessity to save the 'legacy' mother trees and networks so they could pass their wisdom onto the next generation of trees. Every Consultant has a similar responsibility to the next generation of Consultants. He also spoke on the need to reinforce individual integrity and to encourage Legacy Ethical Champions and Consultancies to pass their wisdom onto the next generation of professionals. He also stressed on the need to train, develop and reinforce ethical decision making. It was a very thought provoking and interesting address. He felt that the CEAI Code of Ethics could evolve to encourage cooperative behaviour. He also mentioned his responsibilities as Chair of the FIDIC, IMC - one of them being for the committee to be dedicated to raise awareness, to advocate and to fight against corruption in the global markets, including consulting engineers.

Ms Anna Pinto Herbert, Senior Operations Officer, Integrity Unit of World Bank gave a special address and spoke about the "Corruption Perception Index and Global Corruption Barometer". She reflected on the downside effects of unethical conduct, and how the corruption and lack of transparency in consultancy work could directly impact on project outcomes; in short be responsible for the success or failure of a development program. She spoke about sanctionable practices that were defined under fraud, corruption, coercion, collusion and obstruction, according to the guidelines for IBRD funded projects. Her talk indeed gave the consulting fraternity a lot of food for thought.

PANEL DISCUSSION:

In the first part of the Panel discussion, four panellists from the industry spoke on their focus areas:

Dr Abhijit Dasgupta, Former Jt. Managing Director of M N Dastur & Co talked about ***"Consulting Engineers as Trustee for Employer and Society".*** He mentioned that for consulting engineers, just like for medical doctors, to successfully practise, high esteem, based on mutual trust was the key. For trust to be built by maintaining ethical behaviour is a prerequisite. It is the cornerstone of relationship with their Employer and other stakeholders like suppliers, vendors/ contractors. The trust was also built by merit of the professional services they provide – whether it be in guidance provided in selecting the right site, the state-of-the-art process, an optimum or most economical solutions along with the right choice of suppliers and vendors/ contractors, etc. Professional and personal ethical behaviour thus enhance the integrity, dignity and honour of the engineering profession.

Ms Kalpana Jaishankar, Former Chief Ethics Counsellor, Tata Consulting Engineers talked on ***"Establishing the Ethical Framework: Systems/ Processes & Communication".*** She gave a typical example of how the Code of Business Ethics is implemented in a large organization. She articulated the principles underlying the code and policies (Anti Bribery, Anti Corruption Policy, Anti Money Laundering Policy, Whistle Blower Policy) that support it. She also described the systems/ processes put in place to ensure the success of the program. The need for identifying the Single Point of Contact (SPOC) in terms of Ethics Counsellors at every strata within the organization; Setting up Mechanisms to raise grievances, investigation, disciplinary action, mandating confidentiality and ensuring the process was free from any form of Retribution. She also dwelled on how Ethics was an integral part of the On-Boarding Process and how it was necessary for employees and all stakeholders to understand, sign and accept the Business Code of Ethics. She also talked of the importance of communication about Ethics as a part of every leadership communication; Training on different aspects of the Business Code and its compliance which go a long way in fostering a corporate culture where all one's actions are held to high moral and ethical standards.

Mr. Alok Bhowmick, Managing Director, B&S Engineering Consultants Pvt Ltd made his presentation on ***"Ethics and Integrity – Important traits in Consultancy".*** He said that Ethics & Integrity lie at the core of all engineering decisions, since decisions made by Consultants affect millions of people. He talked of the four important ethical issues that each and every consultant is confronted with on a daily basis - a) Bribery and Corruption; b) Procurement Integrity; c) Conflict of Interest and d) Project Ethics. He briefed about India's place in the Global Corruption Rankings and how bribery has unfortunately gained social acceptance. That results in issues and challenges being faced by consulting engineers. The importance of maintaining a high

ethical standard in CONSULTING cannot be overstated. There should be zero tolerance on violation of code of ethics. He explained the need for integrity in the procurement process - fairly, impartially, legally and transparently. He candidly mentioned that Lack of procurement integrity was widespread in the Consulting Engineering fraternity. He also very aptly described 'Conflict of Interest'. Ultimately it is vital that Engineers, in the fulfillment of their professional duties follow the Fundamental Cannons of Professional Engineers when working in any project.

Lt Col Allan Burby, Advisor, Business Ethics & Compliance talked on ***"Ethical Grievances in a High Performance Culture".*** He elucidated very well the interplay between negative (potentially limiting) and positive (potentially enabling) values and the requirements for a high performing culture. The role of Ethical Leadership and the correlation between value based behaviours and extrinsic motivation of the workforce.

He described a simple Scenario depicting a High-Performance Culture.

In the second part, of the Panel Discussions, all the four panellists and the keynote speakers interacted and provided clarifications on the questions from the audience which were specific and elicited important responses from the discussants. A gist of the interaction and the points made were:

• Ethical behaviour of Consulting Engineers inspires trust and engenders a healthy, long-term working relationship.

• In an organisation, there has to be a mechanism for feedback on ethics, which enables improvement and upgradation of systems. Companies with systems and processes in place can provide guidance to CEAI on how to provide assistance to smaller organisations.

• Ethical challenges are multi-fold, it was not only the responsibility of Consultants but all stakeholders including the Client, Vendors, Contractors and Suppliers. They need to be addressed by every organisation in a manner that suits them best.

• Unethical business practices adds to lack of public trust in Consulting Engineers and in Government and consequently in the infrastructure - examples of failed projects and failed infrastructure can be seen all around us.

• A Consulting Engineering organization should build trust in its own workplace and provide opportunities for Continuous Professional Development of engineers and other technical personnel under their employment, with state-of-the-art knowledge.

• The World Bank considers that every individual in an organisation is responsible for ethical behaviour. Any belie behaviour could be brought to attention of the authority concerned as in the dictum 'if you see something say something'. For WB funded projects any instance of unethical behaviour on its projects could be brought to the attention of the Bank.

• India should prepare its engineers to work outside India .When consulting companies work in a global environment, companies need to make their resources familiar with the law of the country they are operating in and its cultural practices. Some companies do have a well-planned induction or orientation program.

• A habitual offender or one indulging in unethical behaviour reinforces his/her own personal beliefs and value systems. That is why it is important that young professionals are trained to recognise unethical behaviour and taught not to indulge in it. It is not only the individual's responsibility but also of the leadership.

• An example was given of blatant unethical behaviour where an applicant forged the signature of a referral.

• Organisations need to have viable and credible channels of communication in order to maintain the confidentiality of a whistle blower.

• Oftentimes ethical standards come at a cost - so it has to be a long run commitment. There was the recent example of an engineer who was murdered.

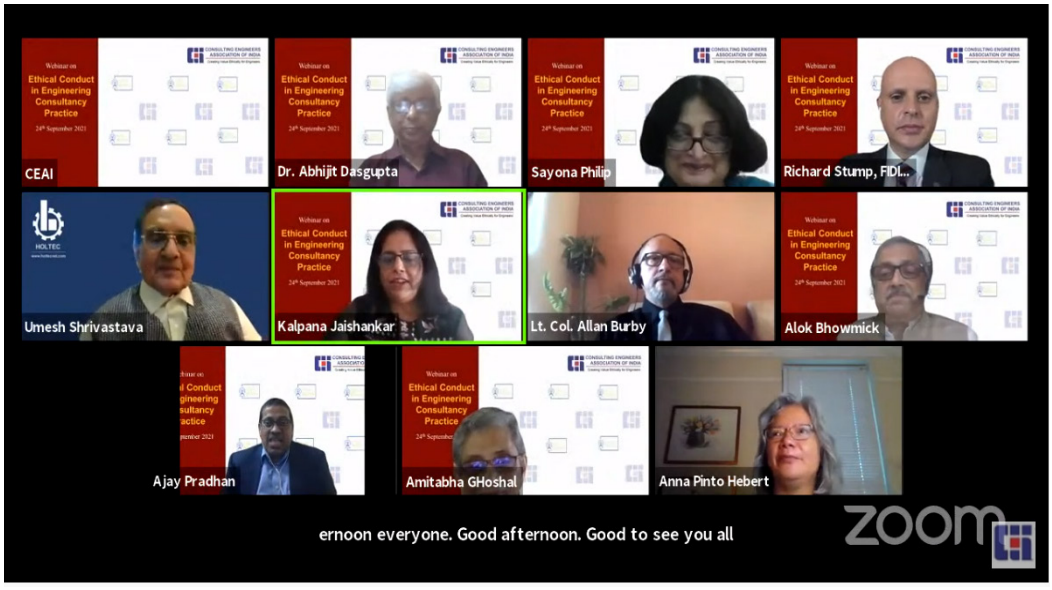
• In case of corrupt practices of an executing agency for a WB project, the WB investigates the complaint. If it implicates a local official, they have an interlocutor with the Ministry of Finance with whom they communicate. The WB also has some legal mandates.

• Ethics is dealt with various international fora at the G20, at the UN. Ethics and integrity is now a global movement.

• The conversation has to continue. There has to be commitment by the individual at the personal level as well as by each and every stake holder.

Mr. Umesh Shrivastava, Chair of the CEAI Ethics Sub Committee proposed the Vote of Thanks and expressed gratefulness to the speakers and the audience for their active participation.

Link: https://youtu.be/5IFcXxwCIsA



CEAI FOUNDATION

Engineers Go Social
CEAI Foundation

CEAI Foundation has been formed as a non-profit body to render engineering support services to the society. CEAI Foundation will promote social initiatives under the theme **"Engineers Go Social".**

The core values of the Foundation are:

Vision

To contribute effective engineering expertise for the Safe, Healthy and Sustainable Living and Development of the Society.

Mission

To assist in creating suitable sustainable, innovative, integrated and cost-effective facilities in association with other social organisations.

Values

• Promote long term solutions for the Society

• Help upgrade knowledge and skill of non-engineering cadre associated with the work

CEAI Foundation has identified three projects of Care India for which engineering support services are being rendered. Care India is a large non-profit organization which has been providing health care services all over India.

The three projects are:

- Thalassaemic Center at Bhagalpur, Bihar

- Thalassaemic Center at Gaya, Bihar

- ICU Ward at Chennai, Tamil Nadu

CEAI Foundation has started rendering services for all the three projects and will be involved in their implementation.

CEAI Foundation is exploring other projects for expanding these activities through the Regional Centres of CEAI.

CEAI Foundation is looking for funding for its activities and invites CSR Funds which will be eligible for Income Tax benefit under section 80G.

NEW VICE PRESIDENT OF CEAI

The Governing Council of CEAI was pleased to accept the nomination of Mr. Alok Bhowmick as the Vice President for the term 2021-2022 in place of Mr. Prashant Kapila who had resigned from the same. Mr. Alok Bhowmick is the Managing Director of B&S Engineering Consultants Pvt. Ltd.

"GUIDELINES ON SUPPLEMENTAL MEASURES FOR DESIGN & CONSTRUCTION OF PRECAST SEGMENTAL BRIDGES"

CEAI has finalized a document on ***"Guidelines on Supplemental Measures for Design & Construction of Precast Segmental Bridges".***

The document is available at

https://drive.google.com/file/d/1cSIwy77bPWsGFFb7KNyLzoC_TR-QwurX/view?usp=sharing

The guidelines have been prepared by the team led by Mr. K K Kapila and assisted by Prof. Mahesh Tandon, Mr. Alok Bhowmick and Mr. V N Heggade. CEAI is pleased to release the Guidelines for adoption by the Bridge industry in the country.

MEMBER NEWS

International Award to Engineer Mr. Avinash Shirode!

Mr. Avinash Shirode, a senior engineer from Nashik working in the field of space science and technology, has been honoured with the International "Excellence Award" by the National Space Society of America.

These Excellence Awards are presented to individuals in the dedicated Space sector to recognize and celebrate the contribution of these individuals to specific community service. Mr. Shirode has been given this award for his various awareness campaigns and initiatives promoting "Space Exploration and Space Settlement".

Avinash Shirode has been the President of the Nashik India Chapter of the National Space Society since its inception. The Nashik India Chapter was inaugurated on 26th February 2016 under the auspices of renowned Atomic Scientist Padma Vibhushan Dr. Anil Kakodkar. The chapter provides information and enlightenment to the specialty students on "Academic and Professional Opportunities in the Space Sector", up-to-date developments in the space sector, and activities of various organizations in the space sector over the next fifty years.

The annual awards ceremony is held on a grand scale at NSS's "International Space Development Conference". The award ceremony was held online last week (8th July 2021) through the internet as all the events were cancelled due to Covid this year.

Every year "World Space Week" is celebrated on a grand scale by Nashik Chapter. The week-long event features lectures and presentations by renowned space scientists. The entire event was celebrated online globally last year due to the Covid epidemic. For this, former chairman of ISRO Mr. Kiran Kumar and former Director of Satellite Center Dr. Annadurai and the other five days were hosted by a presentation by renowned NASA scientists.

Nashik Chapter has already received "Chapter Excellence Award" in 2018, the "Special Merit Award for World Wide Communication" in 2019 and the "David Dunlop International Award" in 2020 for three consecutive years. This year Mr. Shirode has received the "Excellence Award" on individual level.
Avinash Shirode was elected to the Board of Directors of NSS last year (2020). This is the first time a person from India has received this honour.

NSS is an independent educational and non-profit organization dedicated to the field of Space technology for the upliftment of humanity and for the expansion of civilization to other planets in Space beyond Earth and for the exploration and utilization of abundant resources. The agency advises NASA and the US government on Space policy.

BOOK PUBLISHED BY CRC PRESS/T&F TITLED - "ENGINEERING ASPECTS OF HOWRAH BRIDGE AT KOLKATA (1943)

CRC Press/ Taylor & Francis Group has published a book titled "Engineering Aspects of Howrah Bridge at Kolkata (1943)" authored by Shri Amitabha Ghoshal, Past President, CEAI.

As per agreement between CEAI and Taylor & Francis Group (T&F), CEAI Members will get a 30% discount.

Members can order the book at 30% discount by filling the form with the code HBK30. A representative from Taylor & Francis will contact for payment and order fulfilment. Order Form -https://bit.ly/3h5xQ46

FIDIC NEWS

FIDIC ASIA PACIFIC ONLINE CONFERENCE

FIDIC Asia Pacific Online Conference on the theme "New Normal in Engineering Consultancy" was held on 30th July 2021. The event was hosted by the Consulting Engineers Association of Thailand (CEAT).

Mr. Chawlit Chantararat President, CEAT welcomed the Participants and Mr. Anthony Barry, FIDIC President Elect, inaugurated the webinar.

Mr. Amitabha Ghoshal represented CEAI and paved the way for the event with his views on the theme "The Future Effect of Pandemic on Developments in ASPAC Region: Way forward for Consultancy Profession"

The other Speakers were:

Dr. Pornsak Suppataratarn, CEAT Thailand, - "New Era of Engineering Consulting Driven by Technology & Covid"

Mr. Tran Manh Long, VECAS Vietnam - "Post Covid-19 Construction: Adapting to the New Normal"

Ms. Yuan Jing, CNAEC, China - "Our Commitment to becoming a Front-runner in the Infrastructure Construction Whole Process: Consulting Field through Integration and Innovation"

Prof. Mohan Kumaraswamy, Sri Lanka - "Bouncing Back better: Targeting Holistic Best Value with Stakeholder Integration and Supply Chain Resilience"

The webinar was a good opportunity for the participants to share knowledge and experience in dealing with the pandemic and seeking to sustain the industry.

FIDIC PROJECT AWARDS 2021

The winners of the 2021 FIDIC Project Awards have been announced at an online virtual ceremony on 14 September 2021. The successful projects include 22 high-quality construction and infrastructure projects from across the globe.

The awards celebrate outstanding projects where FIDIC member firms have had a major involvement and they also help to publicise the work of consulting engineering firms and the contribution they make to people's quality of life. They also encourage others to understand and support FIDIC principles. In addition, the awards also encourage the use of FIDIC contracts and guidelines and support the aims of the federation which are to promote the use of international FIDIC best practices and resources.

The FIDIC judging panel, chaired by Past President Alain Bentejac, decided to recognise projects with the following awards:

14 Awards of Merit.
7 Awards of Excellence, and
1 Outstanding Project of the Year.

The following CEAI Members received the awards:

Awards of Merit

a) Tata Consulting Engineers Ltd

Bangalore Water Supply and Sewerage Project (II), funded by Japan International Cooperation Agency (JICA)

Increasing per capita water supply from 105 to 150 litres. A significant improvement of 356 MLD.

b) Stup Consultants Pvt Ltd
Narendra Modi Cricket Stadium at Motera, Ahmedabad.

The world's largest cricket stadium.

Awards of Excellence
STUP Consultants Pvt Ltd

Sustainable Water Supply to Rural Habitations in Gadag District, Karnataka State, India

A project that brings water to 1.5 million people (70 l/d) and which is making a significant difference to people's lives.

MR SUDHIR DHAWAN ELECTED PRESIDENT OF FIDIC ASIA PACIFIC

At the General Assembly meeting (GAM) of FIDIC ASIA Pacific held on 30th September 2021, Mr Sudhir Dhawan, Past President CEAI, took over as President of FIDIC Asia Pacific for the period 2021 – 2024. It is for the first time that CEAI representative has been elected to head any FIDIC body. Let us all join to lend our support in raising CEAI status in Asia Pacific region.

OTHER NEWS, VIEWS & NOTES

VIEWPOINT

The theme for the December 2021 issue is "Changing Technologies for Consulting Engineering". The intent is to bring forth the kaleidoscopic changes that are taking place in the business practices and the tools/ facilities for the consulting engineers. Both are witnessing disruptions due to technology and the wake of the Covid 19 pandemic. A typical consulting engineering business is project based with project life cycle spanning from prospecting till operations through the intermediate stages of planning, design, construction and commissioning. Asset management is now also on the anvil.

Each of the phases is being impacted by accelerating technological disruptions. It is not only the sophisticated design tools that are becoming common place but outsourcing and collaborations across the value cycles are gaining traction. Faster, better and cheaper is now a mandate for all. The crucial role that consulting engineering plays during the lifecycle of an asset is increasingly getting recognized and so are expectations from this business. Since it impacts the entire lifetime operations of assets, it has enhanced responsibilities in providing environmentally friendly design, construction, manufacture, operations, maintenance and disposal/ reutilization once the assets life is over. Safety, health and environment in design and operation are increasingly getting crucial.

The business is getting more global and interdependent. The boundaries between competition and collaborations are getting redefined. Outsourcing is progressing from tactical and operational to a transformative arena. This in turn is paving ways for different business models. The geographical based advantages are slowly getting negated by technological advancements.

Based on above, the papers could inter alia cover changing technologies in all areas such as:

a) Energy Transition, Water Management, thrust on Sustainability, addressing Climate Change requirements, Digitalisation, etc. that are becoming a must for projects.

b) Consulting engineering per se such as Tracking and Pursuing Prospective Projects, Bidding, Contracts for Services, Contracts for Works, Smart Engineering (Analysis, Design, Drafting & Visualisation – VR/ AR, etc.), Presentations to clients & public, Collaborative pathways, Knowledge Management, Role of R&D for Consulting firms, Modular Construction Techniques, Project Management (including cost, time, quality, variations, etc.), Advanced Studies/ Simulations/ Specialized Applications, Fire, Health, Safety, Security and Environmental aspects, Disproportionate Collapse of structures, Risks and Mutli-Disaster mitigation, etc.

Professionals – practitioners, academicians and receivers of services are invited to address various aspects of technology led impacts on the consulting engineering business. They are urged to share their knowledge and experience by providing case studies of the works executed or in execution, first-hand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit readers for better appreciation of the issues encountered and the manner in which they were addressed.

The articles for an issue need to reach CEAI at least 3 weeks prior to the end of the month of the View Point issue.

Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin, on A4 size. A recent clear and bright passport size photograph of the author(s) is to be sent along with the article.

Sl. No.	Theme	ViewPoint issue
1	Changing Technologies for Consulting Engineering (to cover Business as well as Technical matters) Guest Editor: Mr. Atul Choudhari, Deputy CTO, TCE	December 2021
2	Becoming *Atmanirbhar* – Concept to Reality Guest Editor: Mr. Pradeep Chaturvedi, Chairman, Interdisciplinary Coordination Committee, IEI	March 2022
3	Contract Management	June 2022
4	Tall Buildings in India (to cover all aspects conceptualisation to end of design life)	September 2022
5	Technology/ Engineering for Sustainability and Circular Economy	December 2022

Advertisement in ViewPoint

VIEWPOINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession. Thus, all stakeholders partnering development and progress are its readers.

Support from CEAI members and stakeholders are sought for increasing the number of advertisements, so that View Point gains in its stature as a unique Technical Publication for the fraternity and the public at large to spread information of how consulting engineers are helping society for improving the quality of life and doing so sustainably.
The rates for advertisements in VIEWPOINT are given below.

Item	Rate Per issue* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover**	25,000/-	80,000/-
Inside Front Cover ***	15,000/-	48,000/-
Inside Back Cover ***	15,000/-	48,000/-
Full Page	10,000/-	32,000/-

**GST @ 5% or as prescribed will be added to the above rates.*
*** Back Cover booked till March 2022*
****Inside Front & Back Covers booked till June 2022 & Sept 21, respectively*

Tech Quiz

1. Which is the earliest known built-up area which had drainage system?

a) Knossos
b) Fermo
c) Ur
d) Rakhighari
e) Çatalhöyük

2. Who started hydrologic modelling?
a) Dalton
b) Chow
c) Darcy
d) Fairbridge
e) Mulvany

3. **The tsunami that killed over 200,000 people in South and Southeast Asia in 2004 was caused by**

a) Volcanic Explosion
b) Earthquake
c) Hurricane
d) Tropical Storm
e) None of the above

4. Which city is credited to have the first modern drainage system?

a) Paris
b) London
c) Boston
d) Bombay
e) Rome

5. Which of the following statement is correct for Natural Ground or Recreational areas?

a) Coefficient of run-off C = 0.1 to 0.25
b) Coefficient of run-off C = 0.8 to 0.95
c) Coefficient of run-off C = 0.4 to 0.6
d) Coefficient of run-off C = 0.6 to 0.95

6. What prevents parts of London from flooding?

a) A retractable barrier
b) Gates in the western part of the city
c) Westerly winds
d) Embankments along Thames
e) None of the above

7. Which of the following is associated with a La Niña event?

a) The Southern Oscillation Index (SOI) is strongly negative.
b) The ocean surface off the coast of South America is warmer than usual.
c) There is an increased chance of above average rainfall in eastern Australia.
d) All of the above.

8. In the future, which of the following is expected to affect the rainfall patterns and the risk of flooding?

a) Population growth
b) Urbanisation
c) Climate Change
d) All the three

9. Which river has the longest stretch flowing through India?

a) Ganga
b) Godavari
c) Mahanadi
d) Brahmaputra
e) Cauvery

10. Which of the following Indian river flows towards West?

a) Ganga
b) Bramhaputra
c) Cauvery
d) Narmada
e) Krishna

The first person who mails the correct answers to CEAI info@ceai.org.in will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue.

Contributed by D G Sonwane and A P Mull

Answers to Tech Quiz June 2021 issue

1(c), 2(d), 3(a), 4(e), 5(b), 6(a), 7(c), 8(d), 9(e), 10(a)

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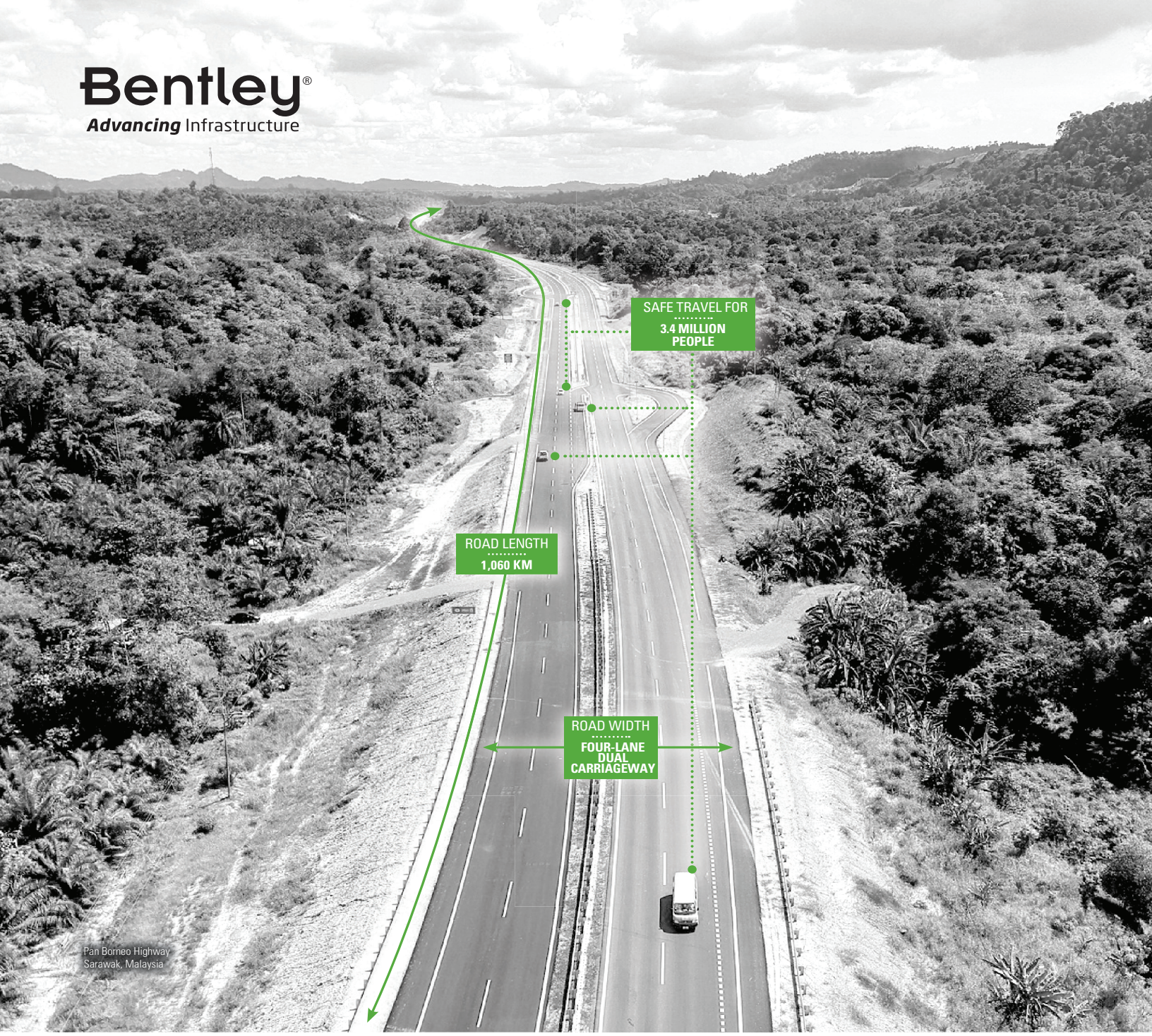

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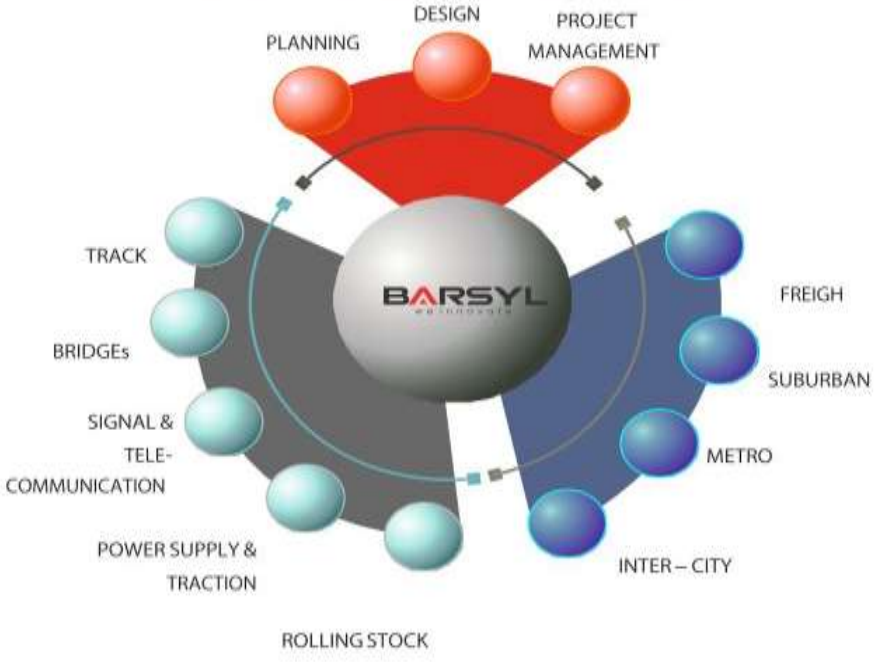

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