

# 6

## RECOMMENDATIONS

### 6.1 Observation

In the foregoing chapters the implications of Rise in Sea Water Level (SLR) because of Global Warming induced changes in climate has been deliberated and the expected rise in sea water level at coast on Mumbai city has been calculated with the help of a well-known state of the art software MIKE 21 FM HD's Climate Change tool.

The Zone of Consideration has been for a length of about 67 km on the Mumbai Sea shore. The Climate Change Tool of MIKE has been applied on a single co- ordinate of Gateway of India. It is assumed that even for the points shown in Pali and Sasane the result will not differ much. The mesh has been generated for a study area till 29.5 km to 52.6 km from the shore, up to a bathymetry of (-) 30 m. The effect of rivers and estuarine flow has not been considered. In the calculation the effect of wind, waves, impact of splashing has not been considered. In absence of data changes for regional gravity field of the Earth ( $\Delta$ SLRG) and Meteo-oceanographic factors ( $\Delta$ SLRM) have not been

considered in this study. In this study the data from altimetry has not been compared for ratification.

The obtained result (viz. a Rise in Sea Water Level of 595 mm at Mumbai during 2050) is validated by comparing with similar results from NASA's tool and Co-Fu's tool from Netherlands. [Chapter IV 4.6 B & C].

Nevertheless, more finer precision results may be obtained by other software like SWAN, Delft-3D or the like, even from MIKE 21 by varying coordinates, bathymetry, including more details about shoreline geometry, wind and wave factors etc. and considering the continuously varying data obtained from recent recurrent extreme weather events, collaborating with IPCC AR6 scenarios and also latest altimetry data from satellites.

## **6.2 Recent Developments**

The Climate Change tool of MIKE-21 is based on the prevalent emission scenarios of CO<sub>2</sub> developed by IPCC in AR4. Results of MIKE 21 are stated to be more reliable than other computational methodologies including Delft 3D Model [51]. This tool is designed to generate projected varying climate parameters such as precipitation, air temperature, and potential evapotranspiration as a function of emission rates and the prediction year and also capable of generating projected rise in sea level. In this study, only projected rise sea level in the year 2050 was generated using the MIKE climate change tool. Comparing global temperature change and CO<sub>2</sub> concentrations between the RCP scenarios and SRES i.e., comparison between AR4 and that of AR5 depicts SRA2 (SRES A1f I) is similar [Figure 3.9] to RCP 8.5 [75].

IPCC's AR4 (2010) considered the Coupled Model Intercomparison Project model CMIP3 whereas AR5 (2013) implemented CMIP5. The latest state-of-the-art climate model CMIP6, developed through a collaboration between India's Ministry of Earth Sciences & NOAA (US), has been

underwritten in IPCC's Sixth Assessment Report (AR6) released in 2021 [103]. The results based on scenarios in IPCC AR4 and AR5, when compared with AR6, is validated as the predicted temperature rises (SRA2:1.650C) till 2050 remains within a similar range (SSP1-1.9: 1.6<sup>0</sup>C to SSP2- 4.5: 2<sup>0</sup>C). The assumption of expected rise 1.5<sup>0</sup>C by 2040 in AR6 and mean global warming from 2046-2065 in AR4 as 1.65<sup>0</sup>C [Table 10.5 Chapter 10: IPCC AR4] appears to be in a compatible acceptance region.

Compared to previous scenarios, "Shared Socio-economic Pathways" (SSPs) in AR6 proposes a broader assessment of a "business as usual scenario" in a world deficient of any change in future policy on climate, with a global heating in 2100 ranging from 3.1<sup>0</sup>C to 5.1<sup>0</sup>C compared to preindustrial levels. It is predicted in future with "growing nationalism" maintaining "well below 2<sup>0</sup>C" matching with Paris agreement target may not turn out as feasible. By 2030, the world needs to reduce ghg emissions by 45-50% below the 2010 level and target to reach net-zero by 2050.

India is the third highest annual polluter of CO<sub>2</sub> in the world, emitting some 2.6Gt of CO<sub>2</sub> annually (<https://www.statista.com>). Even then as per records, till now India is on acceptable range of CO<sub>2</sub> amongst the G20 nations matching with commitments on climate change mitigation set under 2015 Paris Agreement and "well-matched" with the upper goal of restriction of global heating by 2<sup>0</sup>C at the end of the century (Climate Transparency Report 2020).

In spite of the awareness amongst various nations, continuous research and real time follow up by advanced countries through altimetry studies from dedicated satellites, recurring sporadic incidents of perilous weather events, the upshot and consequences of change in climate still has many uncertainties to be accurately predicted. As per current trend of research controlling the warming is warranted, and rise in sea level will depend on how fast and how much the

glaciers in polar regions are going to melt, which depends on the hypotheses named MICI and MISI i.e., Marine Ice Cliff and Marine Ice Sheet Instabilities. However, there exists enormous scope for future work and accordingly the following set of recommendations is put forward.

### **6.3 Potentials for future study**

It is recommended that further research on the following areas demands attention, as the climate change trend is continuously changing.

1. The study area can be extended for a larger length on the shore and a long offshore offset from shore. A complete shore bathymetry as input to the software with iterative simulation would fetch a more correct result.
2. For finding more accurate rise in sea level the effect of 'Ground water component' can be involved by simulating depletion of water from the underground aquifers.
3. Effect of Storm surge up to 4 m or higher in the event of landfall at Mumbai can be simulated to find the extent of damage.
4. Coastal Vulnerability Index can be re-evaluated using most optimum method.
5. Land use plans should be well thought of and premeditated till 2050 or beyond taking into account the extent of probable flooding
6. Detailed Municipal Ward wise & Household Vulnerability Map can be studied.
7. Socio-economic changes due to Sea Level Rise in a post-pandemic global economic slowdown can be studied, in the context of India's intrusion of "phasing down" rather than "phasing out" fossil fuels, as observed at COP26 summit in Glasgow.
8. Revision in IS Codes for Marine Structures (Ports & Harbours) and CRZ regulations are envisaged for which further research by a dedicated task force is necessary.
9. Similar studies can be conducted at the eastern coast of India.