

5

CONCLUSIONS

5.1 Outcome of Research

This thesis on ‘Sea Level Rise due to Climate Change and its Impact along the Coast of Mumbai’ for 30 years period from 2020 to 2050 has been prepared after a thorough research on the subject referring to the contributing factors like Global Warming, Green House Gas effect and related phenomenon. The study and analysis have been based on the scenarios speculated in IPCC's Assessment Report 4 & 5. Out of various historical speculations along with IPCC's serially released Assessment Reports published in 2007 & 2013. In particular the result for a temperature rises up to 1.65°C has been considered from Grinsted's method (2009) as per scenario A2 from Special Report of IPCC and presented in Table 4.2 in Chapter 4.

SRA2 corresponds to cumulative CO_2 emissions as 600 and 1850 Gt of C and CO_2 concentrations 575 and 870 ppm (parts per million) till 2050 & 2100 respectively [102].

The importance and objectives of the research has been stated in the Introduction chapter. The study area for the purpose of simulation inputs in MIKE software has been taken up to a bathymetry of (-) 30 m in the sea area. After a protracted Review of Literature and explaining the methodology; the result on Sea Level Rise at Gateway of India (Latitude/Longitude = 18.9220° N, 72.8347° E) in 2050, obtained using MIKE software, the technical discussions (touching upon the limitations of the study) have been presented in para 4.6 Chapter IV. The consequences of SLR on the coast of Mumbai (2050) have been presented in in Chapter IV (Figure 4.15 and Figure 4.19).

5.2 Conclusion

Synoptically the following non-exhaustive list of findings are concluded from the subject study:

1. Rise in Sea-level is happening because of warming and Greenhouse Effect is the resultant of Global Warming. Along with Global Greenhouse Gas (GHG) emissions expansion of sea water and decrease in land-ice mass contributes to Rise in the Global Mean of Sea Water Level. Human activities are foremost trigger for Change in Climate and plays very important part in increasing vulnerability of coastlines.
2. Because of ongoing melting of ice in glaciers in polar region huge quantity of additional melt water is also likely to largely contribute to further sea level rise. In spite of Altimetry measurements through satellites and Remote Sensing, the exact sea level rise till now remains too difficult to be determined correctly.
3. Mumbai, is highly vulnerable to increase in Sea Water Level due to heating all around our Globe. It ranks 2nd in a list of 136 vulnerable coastal cities

around the world, which will face the highest risks [33].

4. From the perspective of Paris Agreement Compatibility, the temperature rise at Mumbai can be reasonably considered well below 2°C but not much above 1.5°C from A2 scenario, which aims for regional development.
5. As per the said explanations, under Temperature rise of 1.65°C in SRA2 scenario Grinsted's method is considered to suit (rise in temperature 2nd highest amongst the values in Table 4.1) and hence along with IPCC AR4's method, Grinsted et al.'s (2009) method [11] is time tested and has been incorporated in MIKE 21 for implementation of the result.
6. Relative SLR at Mumbai is approximately 0.8 mm/year (MoES) and the indication remains the RSLR is on the upper trend (NOAA). Attempt to reduce high-emissions scenario is going to continue, which is referred as “business as usual” scenario.
7. The Sea Level Rise at Mumbai coast on account of temperature rise only obtained through MIKE 21 in 2050 will be 0.395 m [Para 4.2.2.1 Chapter IV], which excludes meteo-oceanic factors and possible fluctuations in gravitational field,
8. Adding a value of 0.200 m on account of vertical land movement the total Sea Level Rise at Mumbai coast is found as 0.595 m [Para 4.2.2.2 Chapter IV].
9. From the point of view of storm surge potential vulnerability of Mumbai coast falls under Very high-risk zones (Surge height $> 5\text{m}$) [INCOS], which will increase the level of water at Sea causing severe inundation in the city.
10. To combat with the slamming force generating out of Sea Level rise, the

clause 6.3.7 in IS 4651 (Part V) warrants attention, which may have to be revisited/ changed. Additional provision for free board in future design of Jetties/Other Marine Structure in Mumbai region during 2050 and beyond is envisaged.

11. Tidal Rise at Mumbai till 2050 from 2020 will be in the range of 3.1 cm to 7.8 cm
12. Highest High Water so far recorded 2.87 m above MSL is likely to theoretically increase upto + 3.47 m above MSL. With surges up to 5 to 7 m during cyclone, the sea water level is likely to further increase and possibility of huge flood cannot be ruled out.
13. To accommodate the diurnal changes between High and Low Tide in 2050, Luffing cranes will be required by all Ports in Mumbai region. Passenger Ferry launch movements in coastal periphery around Mumbai will be affected. Relocation of berthing Jetties is envisaged.
14. Upto 500 m from HTL (The Line of High Tide) in the coasts and upto 100 m along estuaries, backwater and rivers, banks of creeks, which face tidal fluctuations, fall under Coastal Regulation Zone. Sea Level Rise will affect the High Tide Level and cause shoreline retreat, hence consequential changes in CRZ regulations due to Sea Level Rise are envisaged in future.
15. Flooding in Mumbai City for pluvial causes will further aggravate due to Sea Level Rise during Tidal Lock Period under congestion in the antique drainage system.