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APPENDICES

APPENDIX – I

PERTINENT TECHNICAL DATA

PERTINENT TECHNICAL DATA

I. VARIOUS ENGINEERING LEVELS AT MUMBAI

(Final Report MMRDA's Fact Finding Committee on Mumbai Floods (March 2006)

The following pertinent facts have been noted in the study for reference.

- No of City Sewer Outfall = 186, Below MSL = 45
- Outfalls at lower than HTL High Tide Level but at higher than MSL =135
- Outfalls above High tide level = 6

(i) Mumbai Port Trust reports the levels of Tide against Chart Datum (Port's benchmark) not against MSL. This helps ship's captains to see CD of Port British Admiralty Chart (as done for all ports in world).

(ii) Mumbai Port CD is 2.51 below Mean Sea Level

(iii) The level on the is however City area Levels are based on Town Hall (Datum)

(iv) MSL around Mumbai is near GTS (Great Trigonometric Survey of India) datum zero which is recognized by Survey of India.

v) MSL of Mumbai is equivalent to 0.01 m GTS

(vi) The interrelation amid THD, MSL & CD are:

- MSL is equivalent to 24.46 M. THD
- Chart Datum is equivalent to 21.95 M.THD
- City's Town Hall Datum (THD) is equivalent to 100' (Hundred feet) i.e.,30.48 m
- City's Town Hall Datum (THD) Level in m – 24.46 m = Level as per GTS in m
- C.D. Level at MbPT – 2.50m = Level as per GTS in m

(vii) HTL is considered as +5.40 CD (+2.87 m above MSL) as this is the most likely high level of sea water during the passage of a storm.

(viii) Level at Pavement of Gateway of India: +6 M

(viii) Footpath level on the lee side was raised upto +7.5m

(ix) The crest level of Sea Guard Wall at Marine Drive is raised to about +8.5 to +9.0m to arrest splashing of water

(x) Marine Drive / Nariman Point Level: +6 M from MSL

(xi) Road Top Versova Nariman Point Road = +8 M from MSL

(xii) Berth Top JNPT = +7.15 M from CD

(xiii) Airport Level = + 11 M above MSL

II. GTM RESULTS FROM MIKE FROM 2021 TO 2050

The projection of Tide Level Variation till 2050 was obtained from MIKE.
However, as the focus of this research is on Global Heating and its impact on Rise in Sea Level and Climate Change Tool takes care of these tidal differences as per in-built provisionsin the programme the tidal difference is not added with Rise in Sea Level
The inundation charts for the period from 2021 to 2050 are presented below.

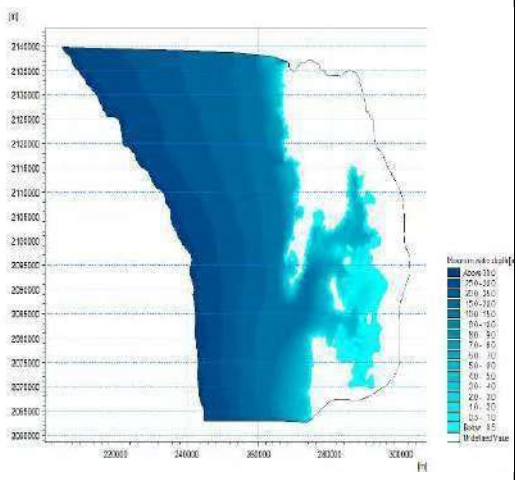


Figure 1: Maximum water depth (m) inundation in 2021

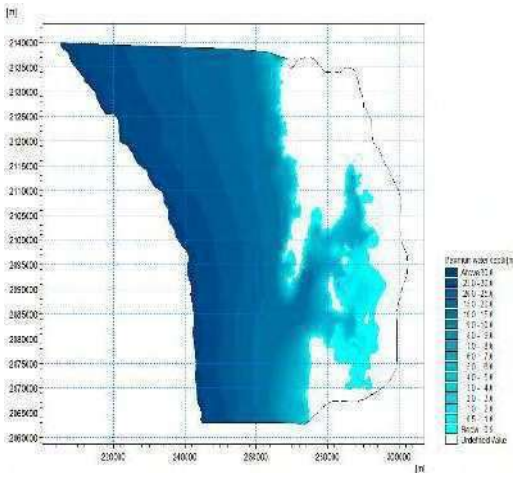


Figure 2: Maximum water depth (m) inundation in 2022

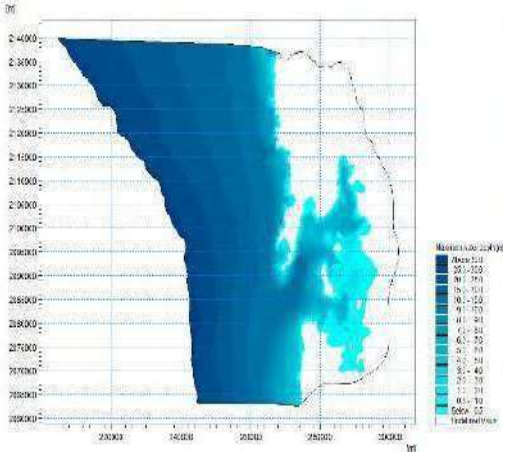


Figure 3: Maximum water depth (m) inundation in 2023

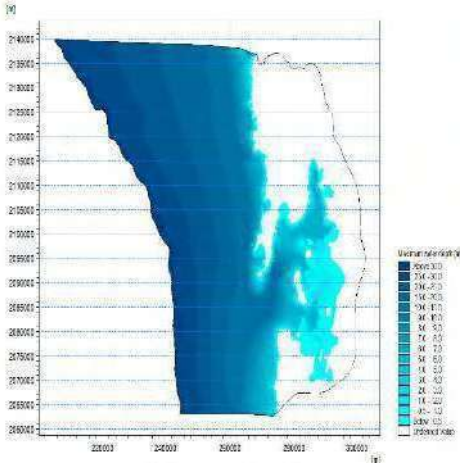


Figure 4: Maximum water depth (m) inundation in 2024

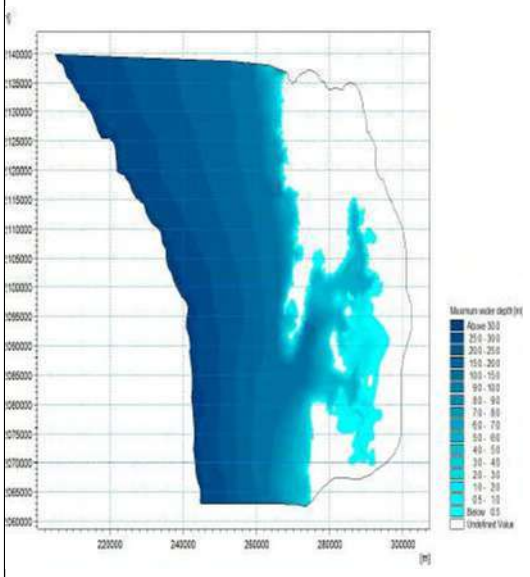


Figure 5: Maximum water depth (m) inundation in 2025

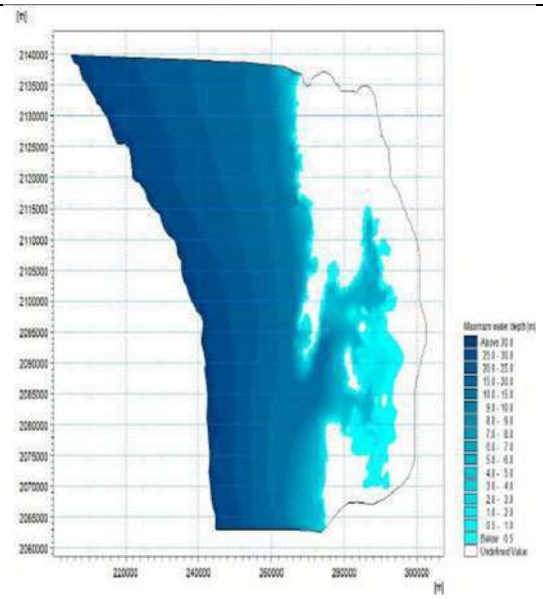


Figure 6: Maximum water depth (m) inundation in 2026

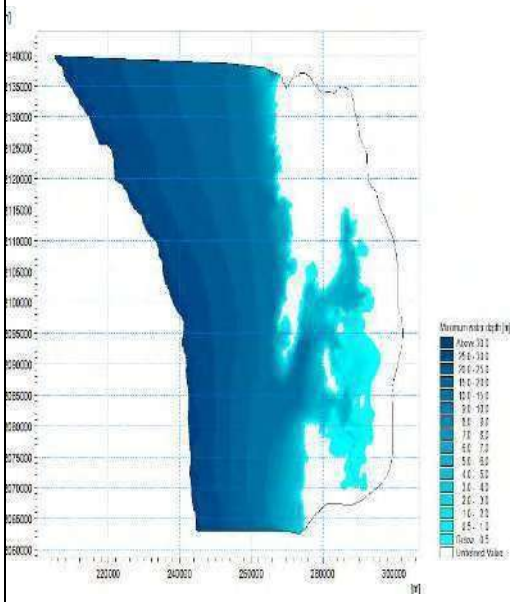


Figure 7: Maximum water depth (m) inundation in 2027

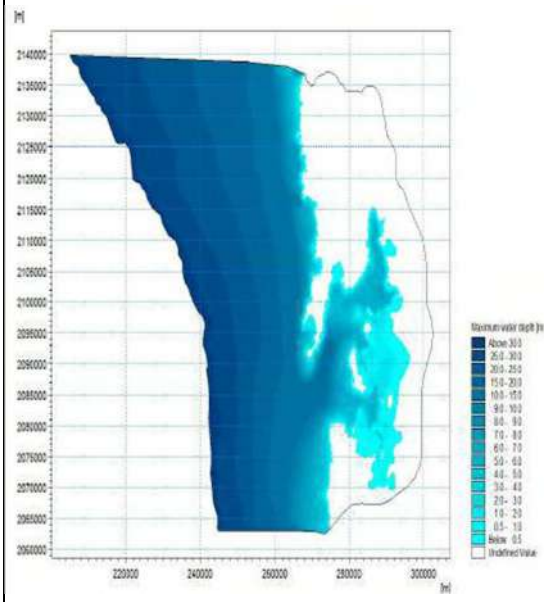


Figure 8: Maximum water depth (m) inundation in 2028

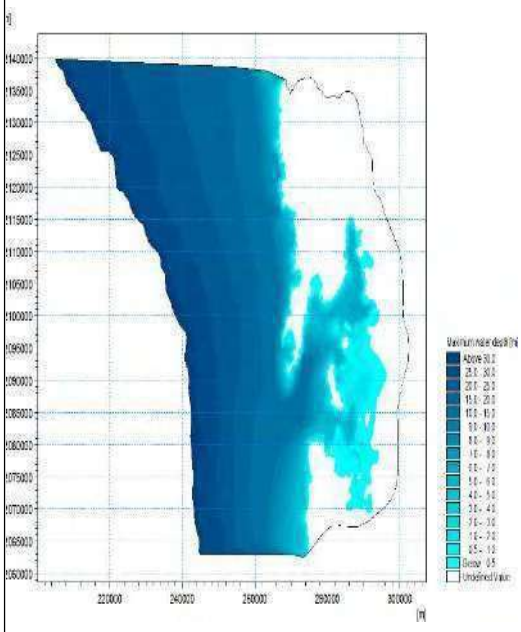


Figure 9: Maximum water depth (m) inundation in 2029

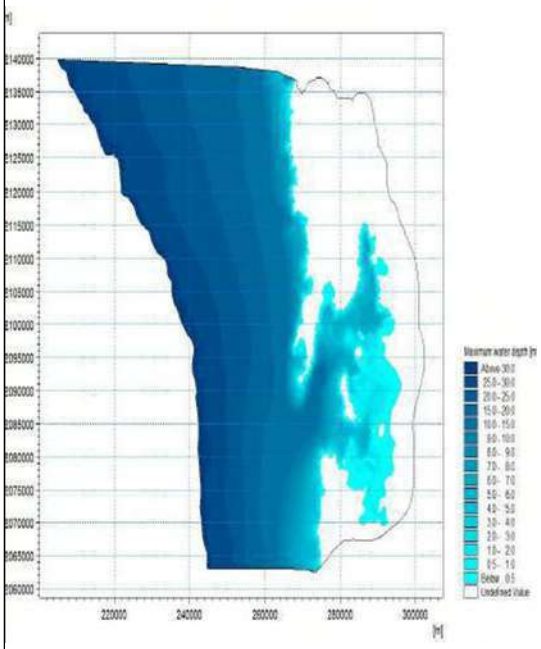


Figure 10 : Maximum water depth (m) inundation in 2030

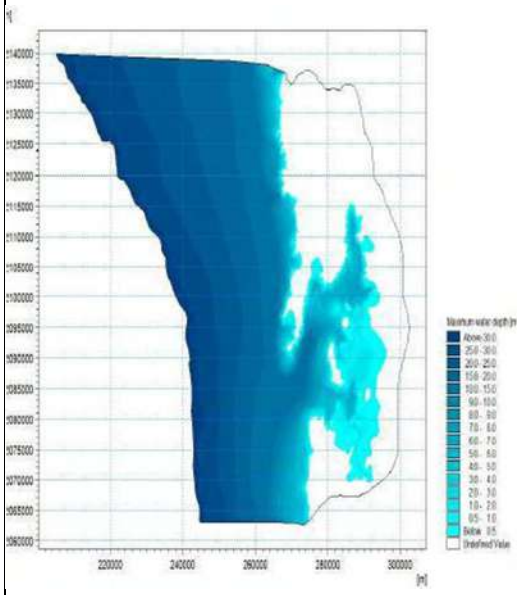


Figure 11: Maximum water depth (m) inundation in 2031

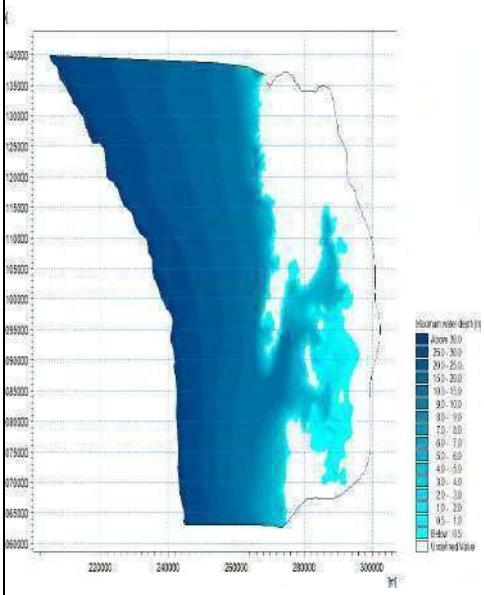


Figure 12: Maximum water depth (m)inundation in 2032

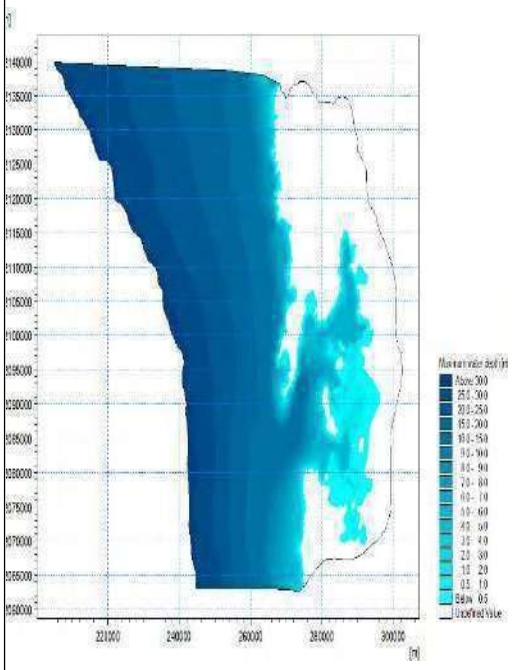


Figure 13: Maximum water depth (m) inundation in 2033

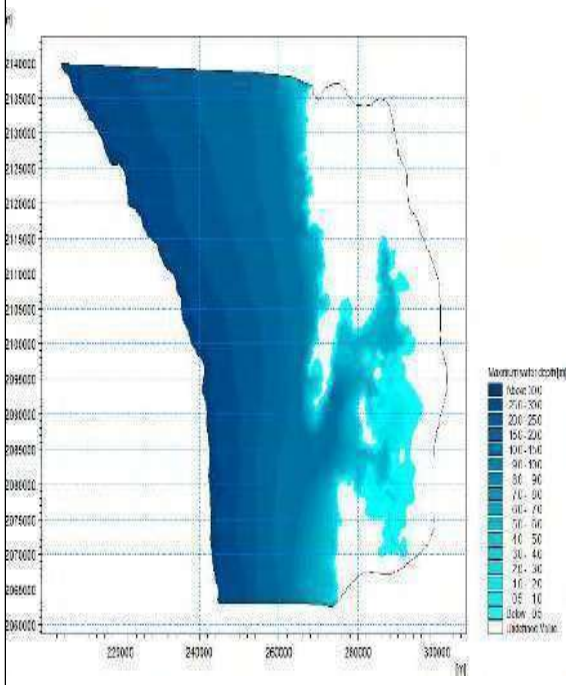


Figure 14: Maximum water depth (m) inundation in 2034

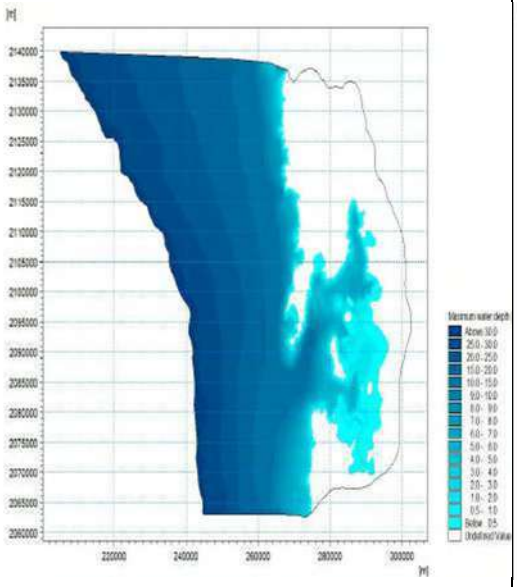


Figure 15: Maximum water depth (m) inundation in 2035

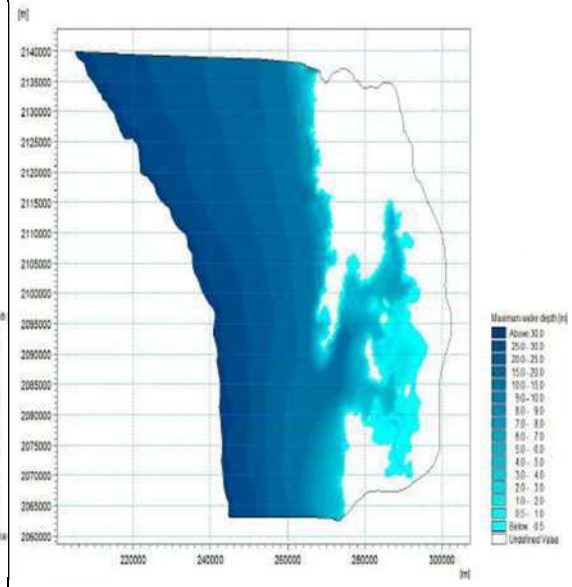


Figure 16: Maximum water depth (m) inundation in 2036

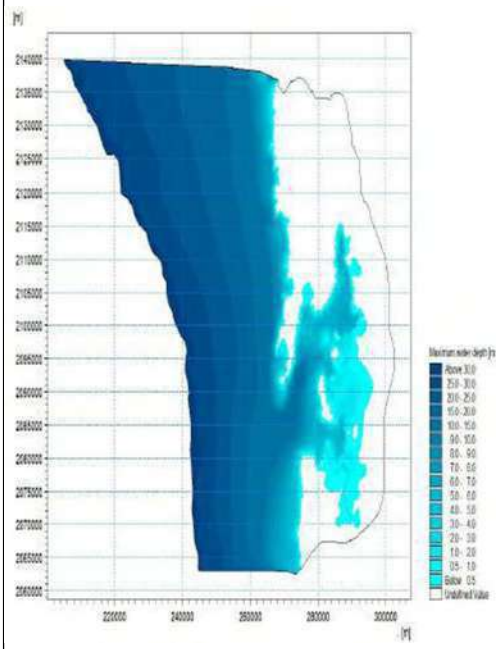


Figure 17: Maximum water depth (m) inundation in 2037

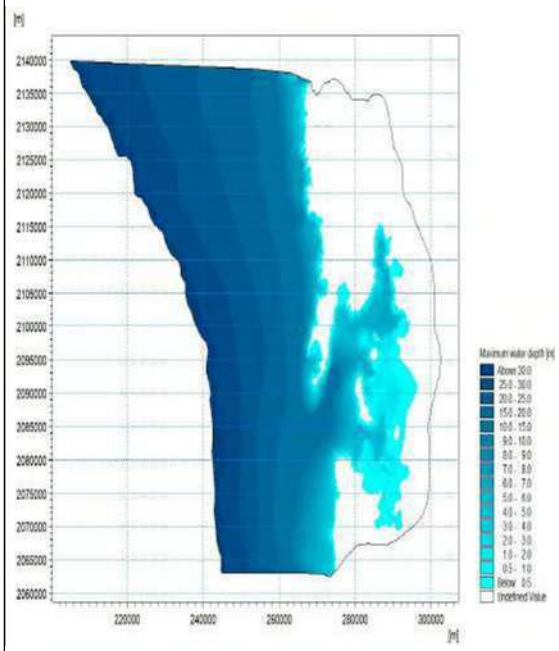


Figure 18: Maximum water depth (m) inundation in 2038

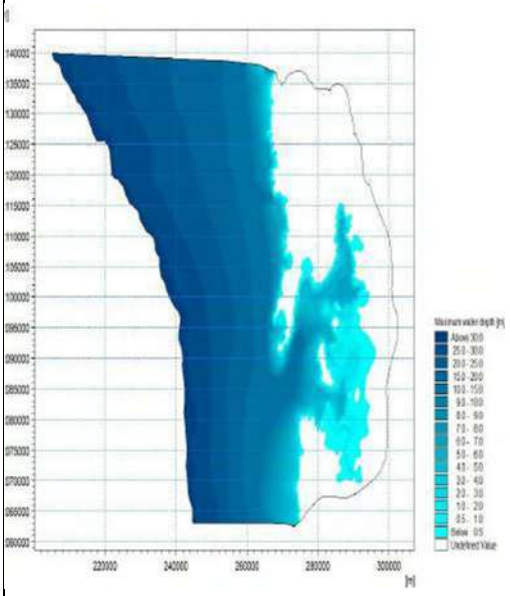


Figure19: Maximum water depth (m) inundation in 2039

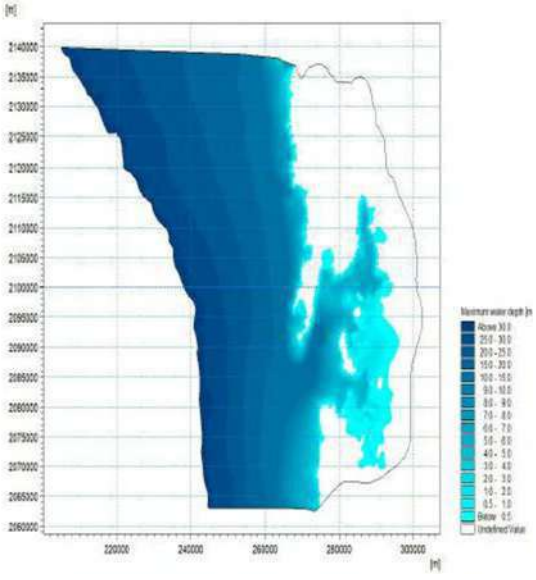


Figure 20: Maximum water depth (m) inundation in 2040

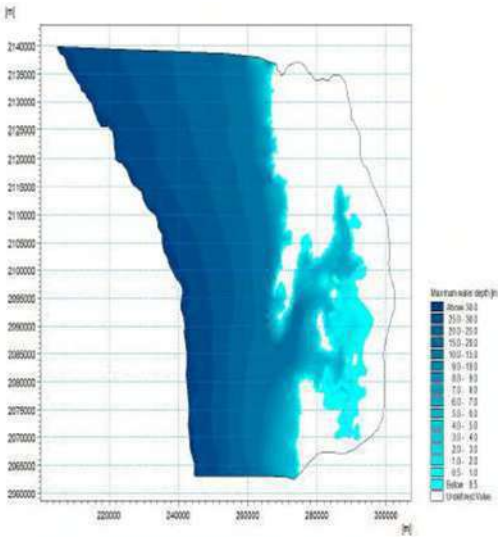


Figure 21: Maximum water depth (m) inundation in 2041

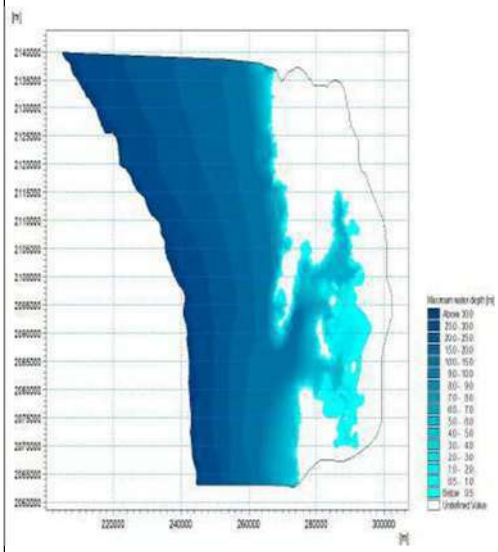


Figure 22: Maximum water depth (m) inundation in 2042

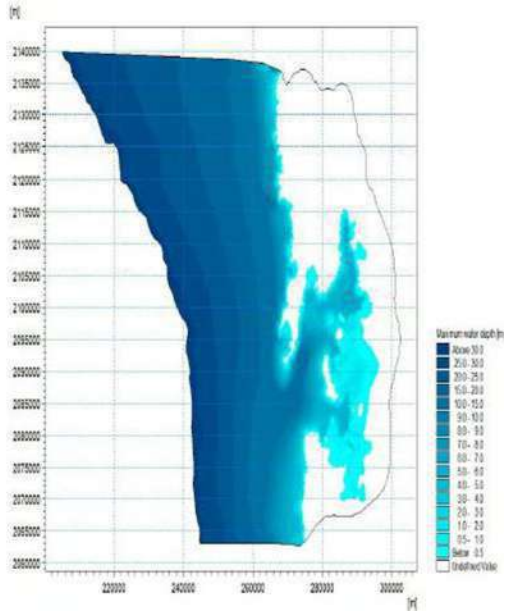


Figure 23: Maximum water depth (m) inundation in 2043

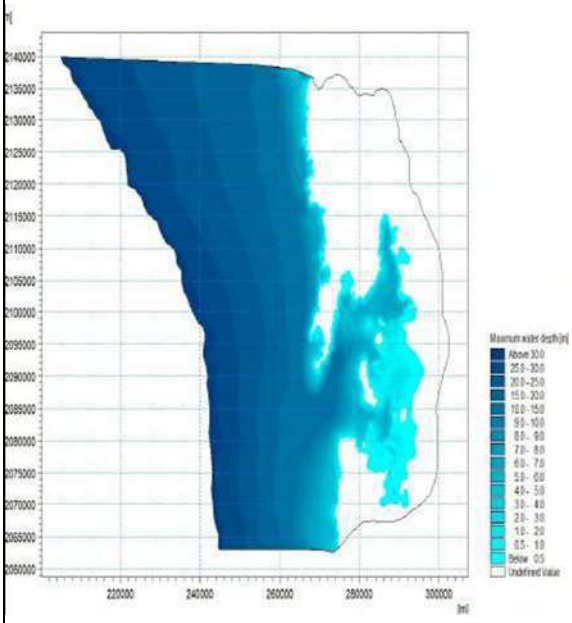


Figure 24: Maximum water depth (m) inundation in 2044

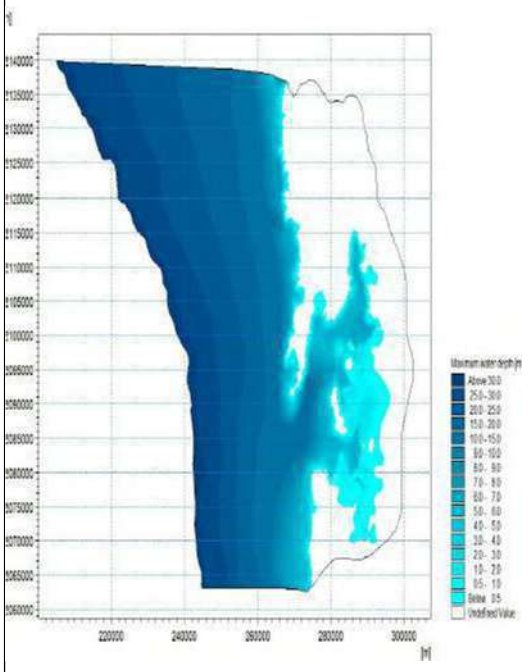


Figure 25: Maximum water depth (m) inundation in 2045

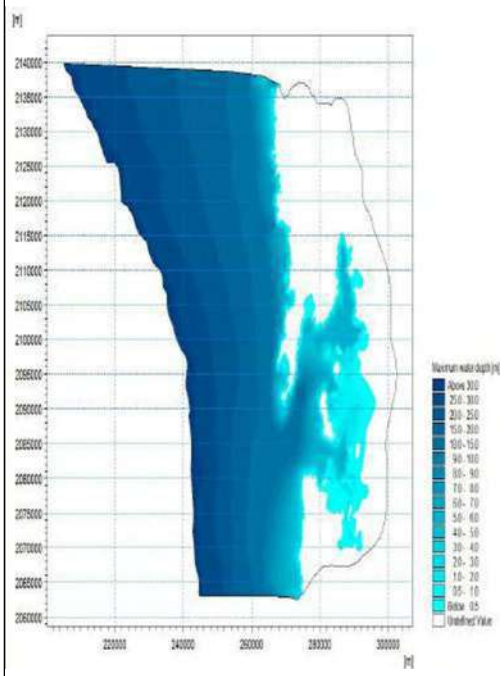


Figure 26: Maximum water depth (m) inundation in 2046

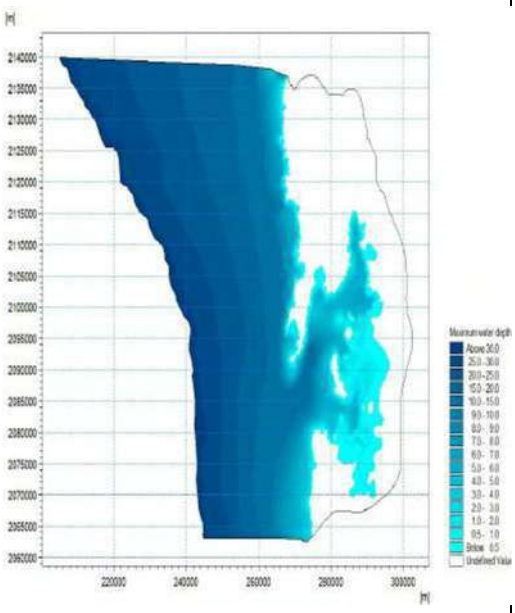


Figure 27: Maximum water depth (m) inundation in 2047

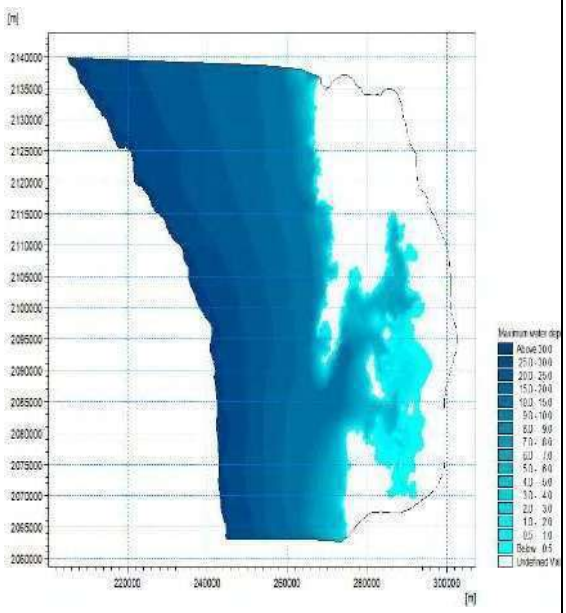


Figure 28: Maximum water depth (m) inundation in 2048

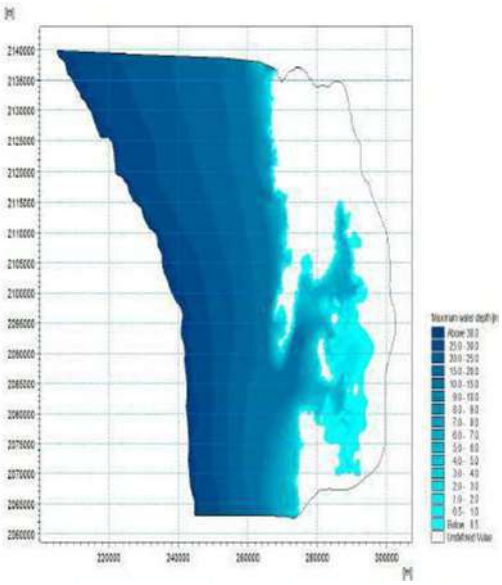


Figure 29: Maximum water depth (m) inundation in 2049

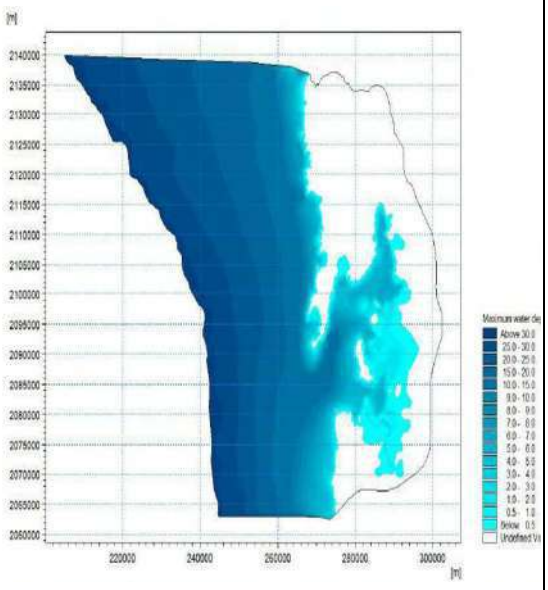
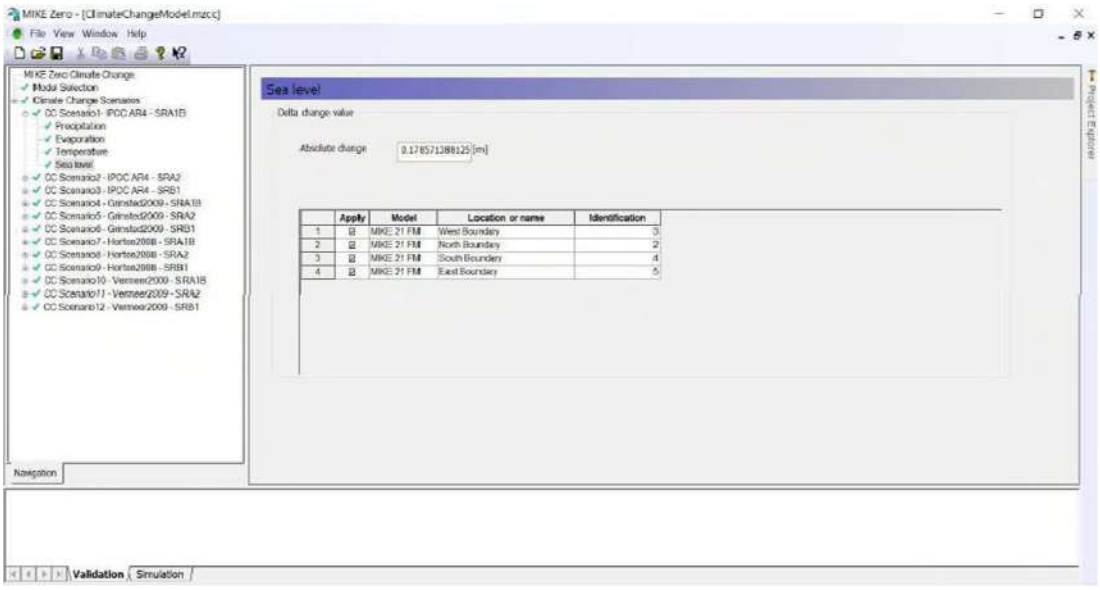


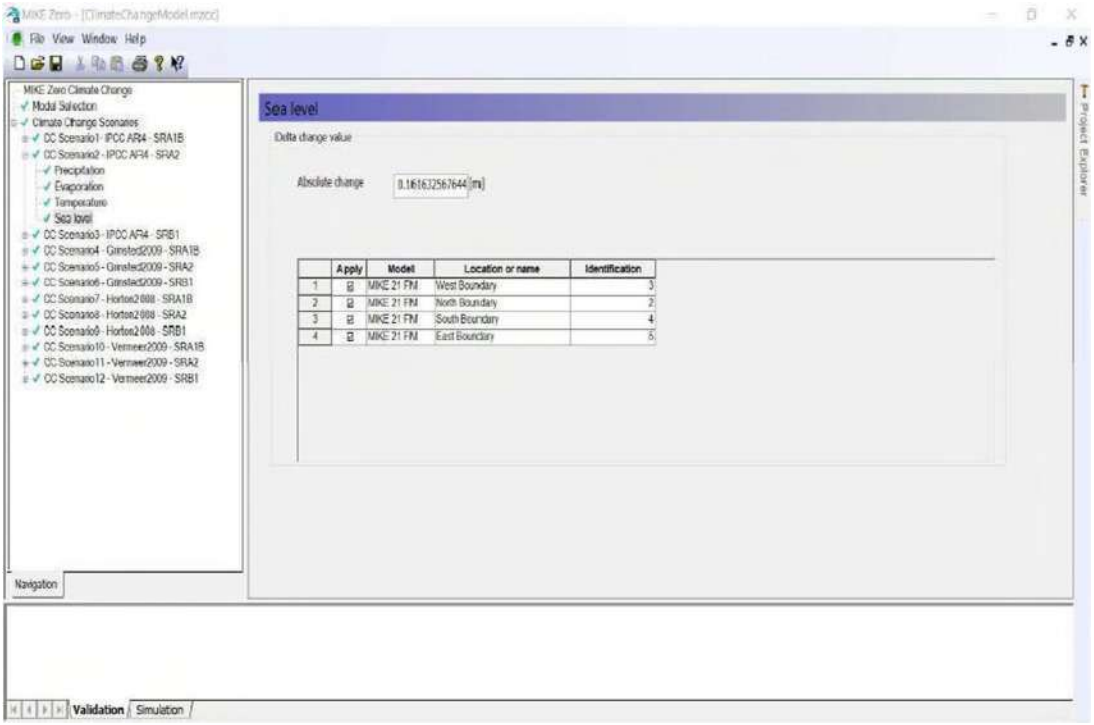
Figure.30: Maximum water depth (m) inundation in 2050

III. RESULTS & RELATED SCREENSHOTS FROM MIKE OUTPUT

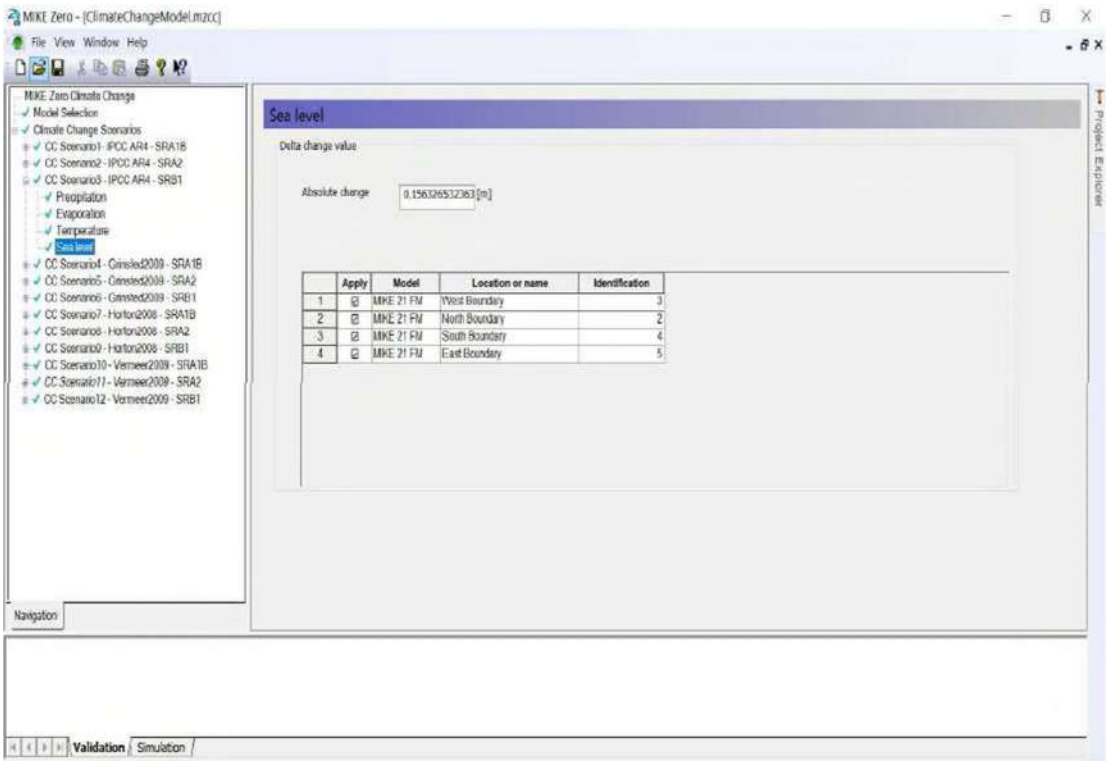
Methods	Projected sea level rise (m) in 2050			Reference
	SRA 1B	SRA2	SRB1	
IPCC AR4	0.179	0.162	0.156	Meehl et al. (2007)
Grinsted 2009	0.415	0.421	0.370	Grinsted et al. (2009)
Horton 2008	0.249	0.254	0.223	Horton et al. (2008)
Vermeer 2009	0.431	0.431	0.395	Vermeer and Rahmstorf (2009)



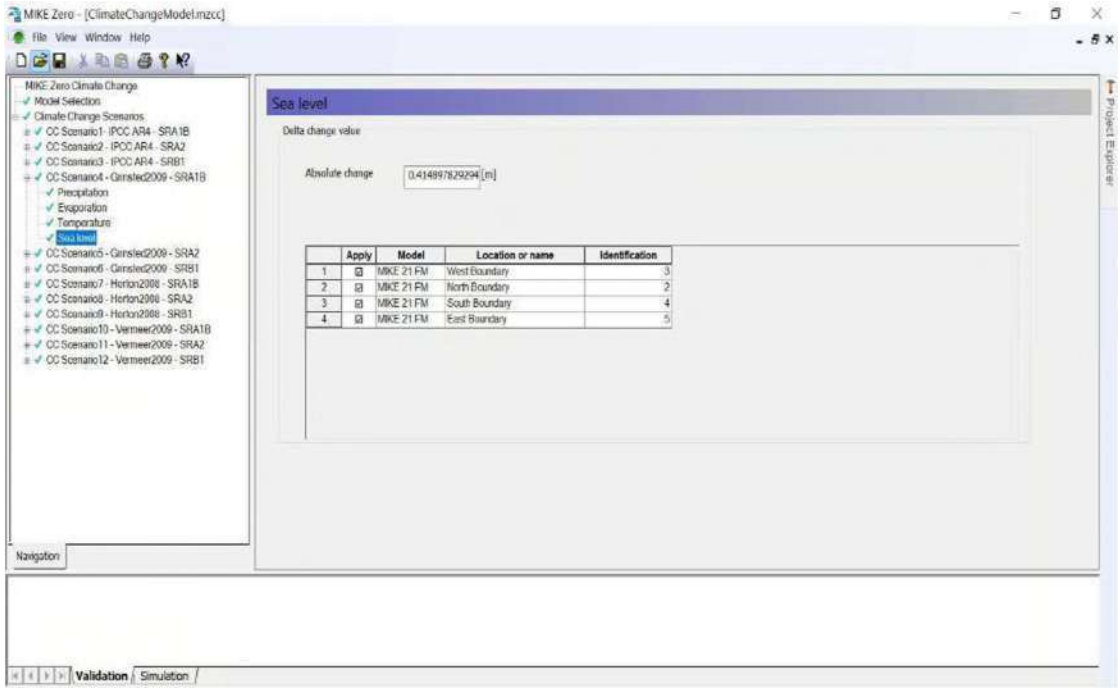
IPCC AR4 SRA 1B



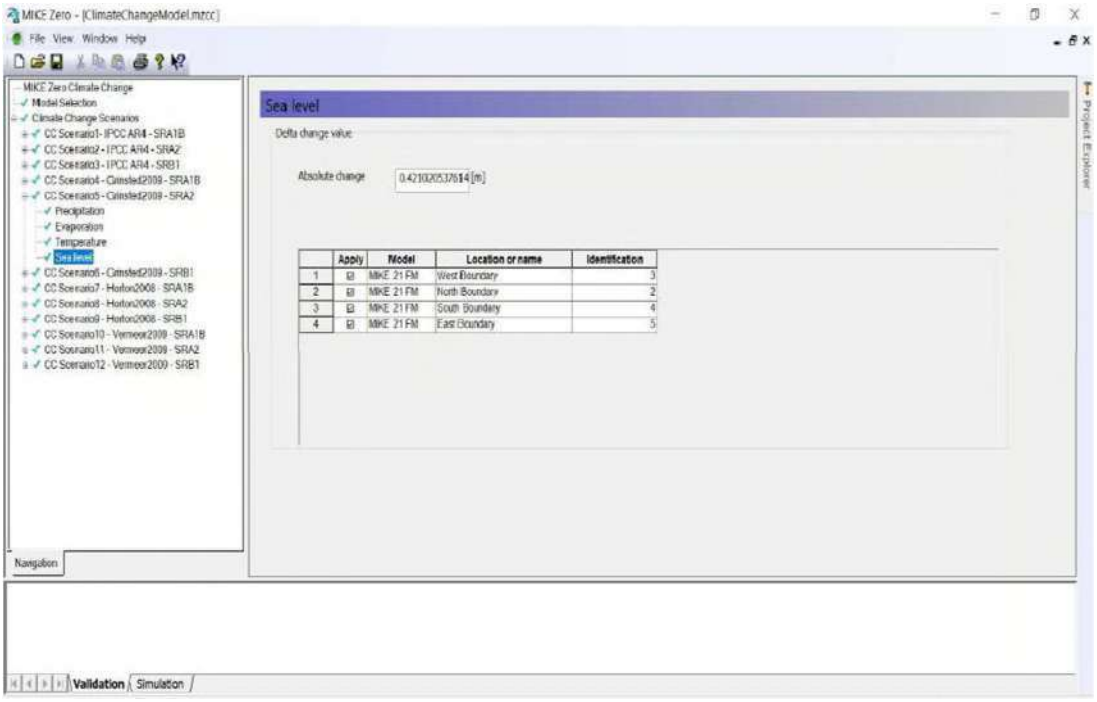
IPCC AR4 SRA2



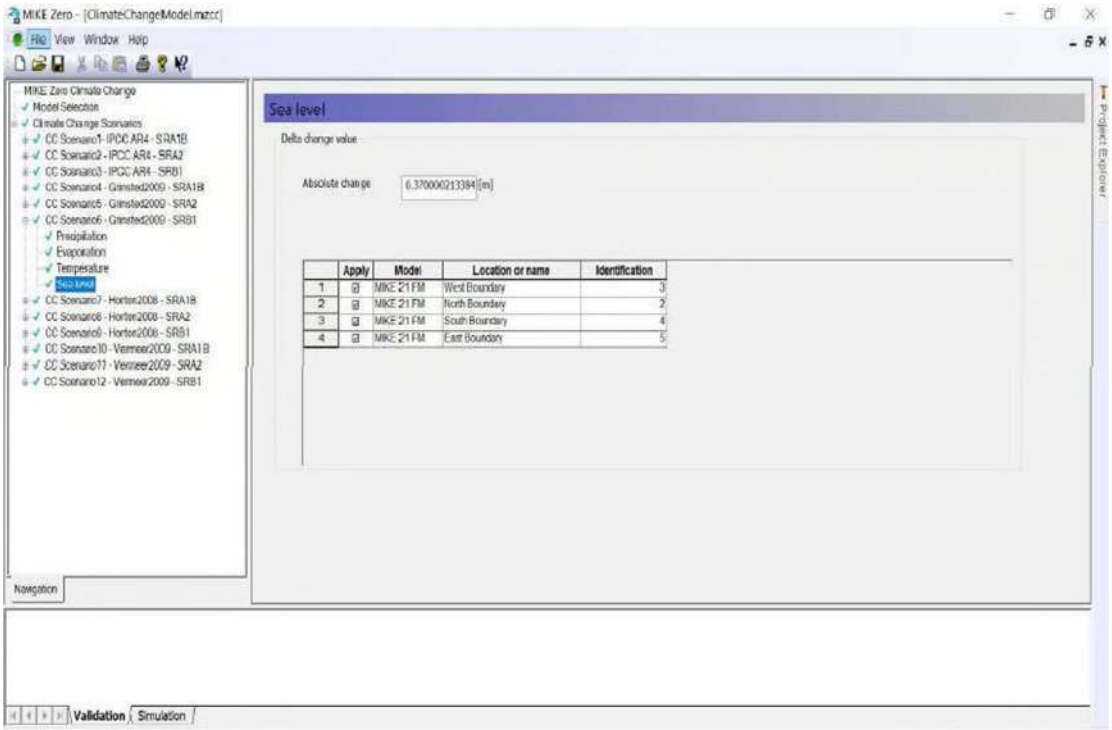
IPCC AR4 SRB1



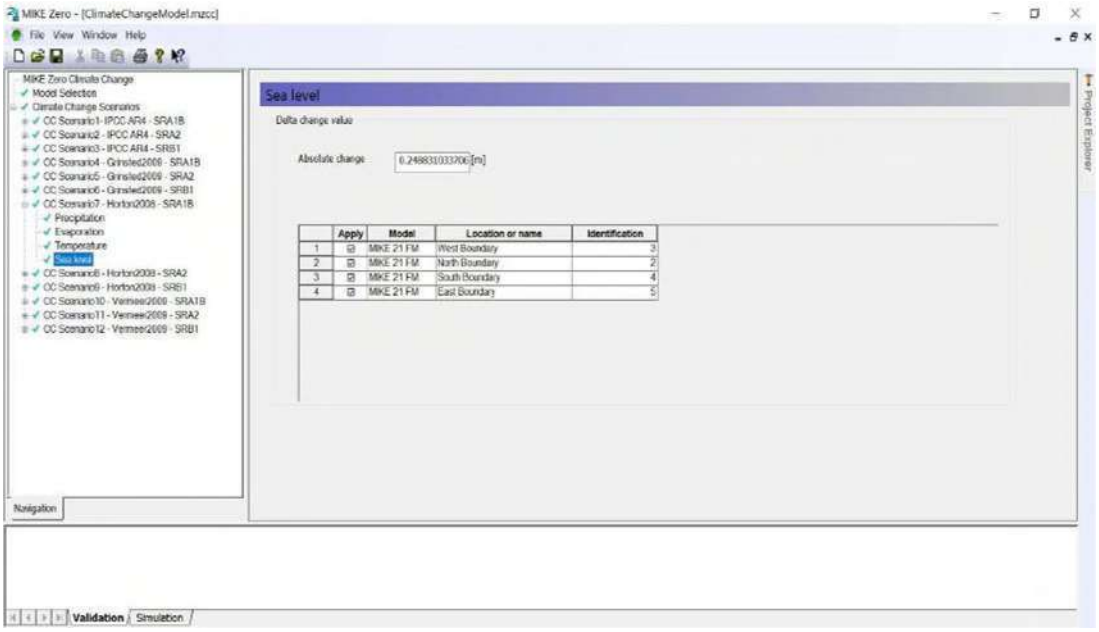
Grinsted 2009 SRA1B



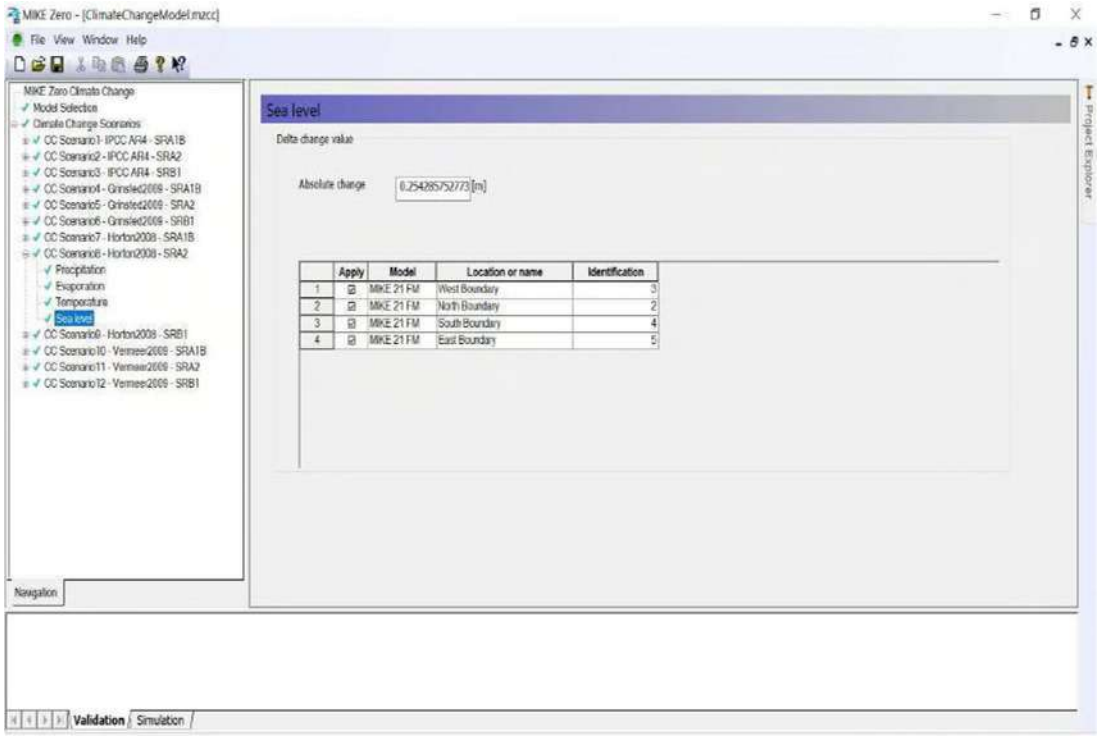
Grinsted 2009 SRA2



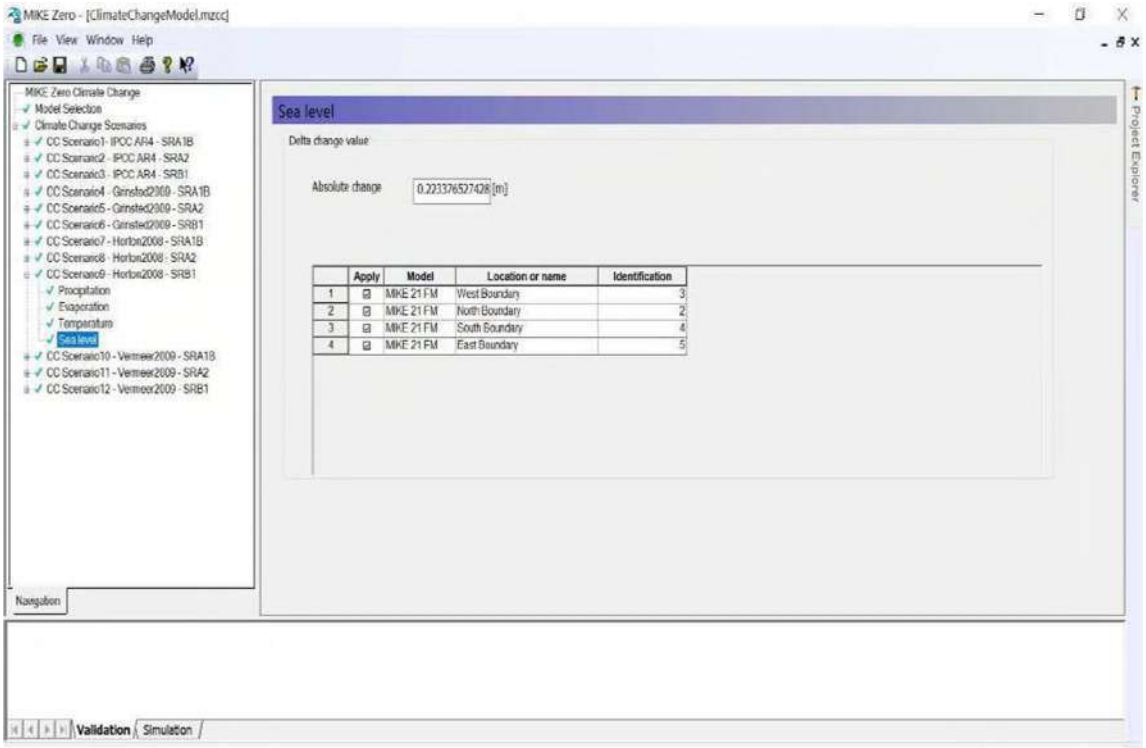
Grinsted 2009 SRB1



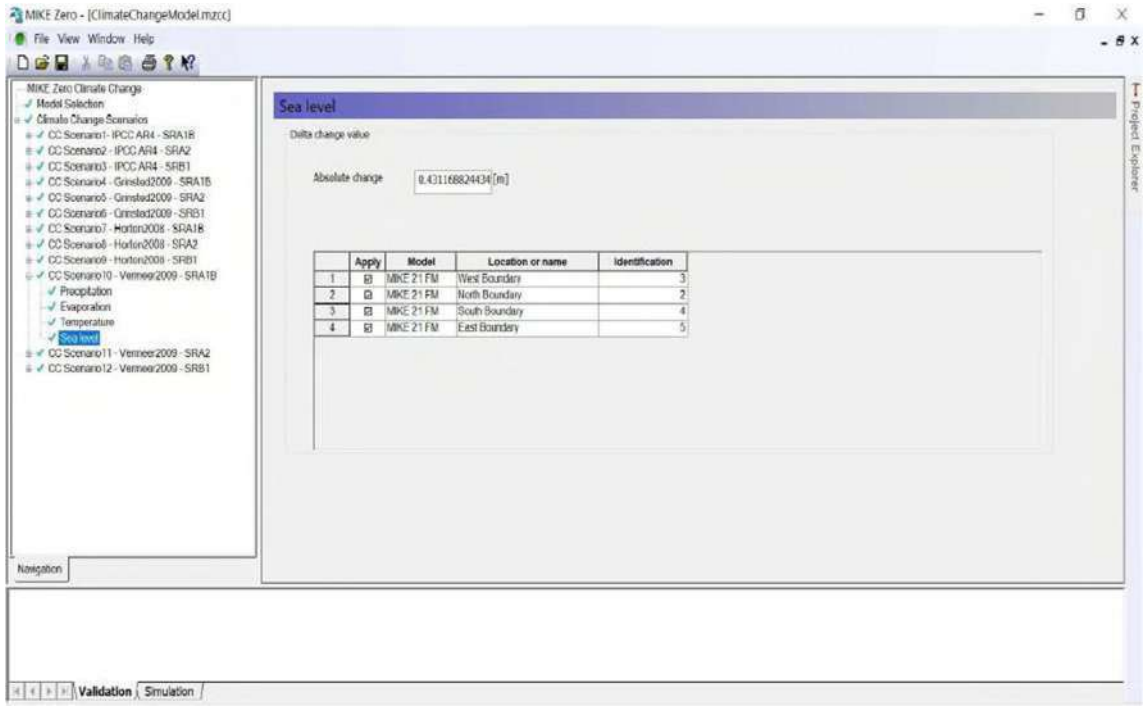
Horton 2008 SRA1B

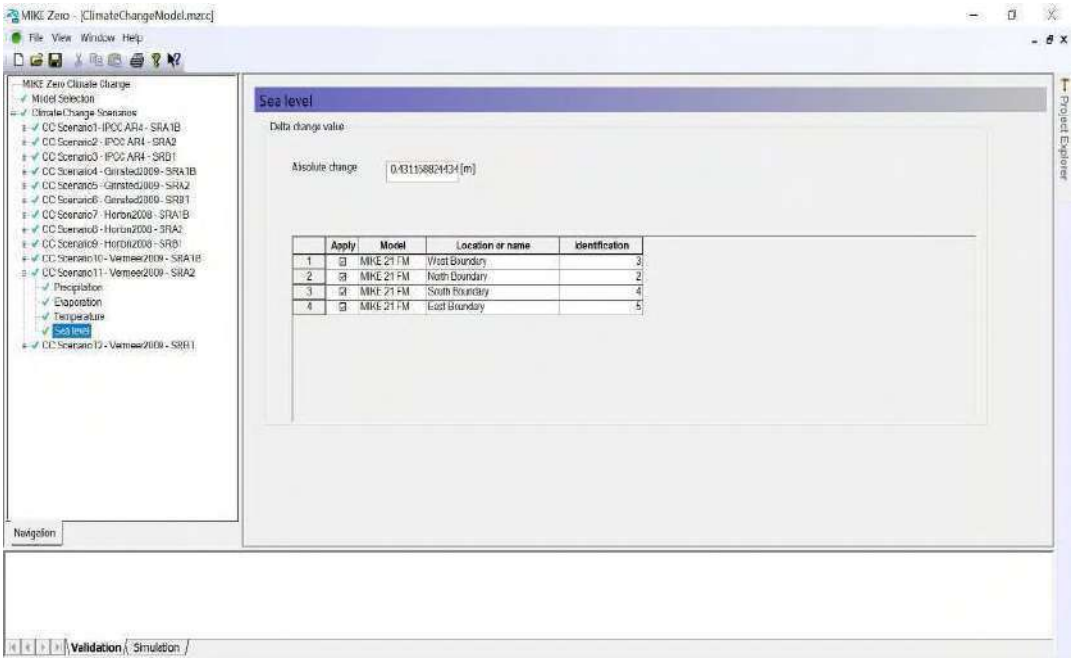


Horton 2008 SRA2

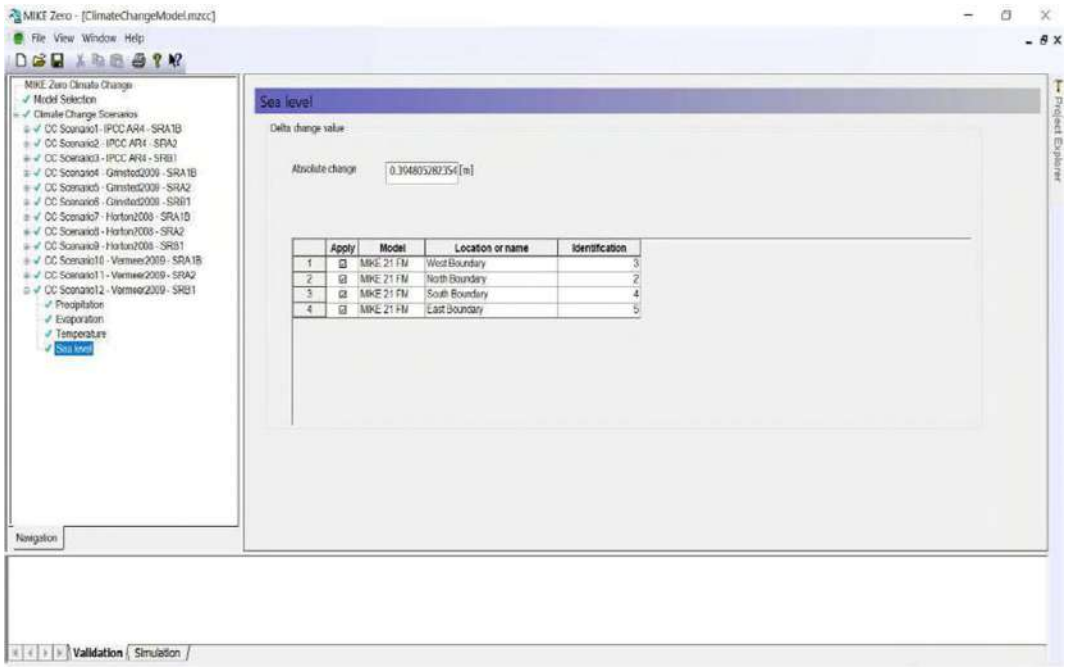


Horton 2008 SRB1





Vermeer2009 SRA2



Vermeer2009 SRB1

APPENDIX-II

PERMISSION FROM DHI

FOR USING MIKE

Agreement for Educational Time-limited MIKE Powered by DHI Software Licence

DHI, Agern Allé 5, DK-2970 Hørsholm, Denmark (hereinafter called DHI) is granting: **The Assam Royal Global University, Guwahati** (hereinafter called the University) a 6-months' licence to use selected MIKE Powered by DHI Software for educational purposes in pursuit of an academic qualification.	
The MIKE Powered by DHI Software covered by this Agreement is specified below: MIKE 21 HD FM SW and it will be applied to dongle number:	[insert dongle number]
Applicant Details: Name:	MR. SUDIPTA CHAKRABORTY (in the following referred to as User)
University Address:	The Assam Royal Global University, Betkuchi, NH-37, Guwahati, Assam-781035, India.
Supervisor Name:	Dr. Arnab Sarma Ph.D. (Mendel University), M. ASCE, F. IWRS, F.IAH Professor & Head, Dept. of Civil Engineering Royal School of Engineering & Technology The Assam Royal Global University
Course of Studies:	PhD – Civil Engineering Qualification of student: Master of Engineering (Coastal Engineering) [IHE, Delft, The Netherlands]
Title of Thesis:	Sea Level Rise due to Climate Change and its Impact on the Coast of Mumbai

Short description of intended use of the MIKE Powered by DHI software products in the project:

In the proposed research, using the data from DHI viz. (i) Bathymetry data: C-Map, (ii) Water level boundary: extraction from Tidal model & (iii) Wave boundary: extraction from Global Wave model ; the MIKE 21 HD FM SW from DHI will be used for academic purpose to predict the Sea Level Rise along Mumbai coast up to 2050.

The objective of the research work for fulfilment of the requirements for a PhD degree are:

1. *To analyse sea level rise predictions due to climate change along Mumbai coast*
2. *To predict the Sea Level Rise along Mumbai coast up to 2050*
3. *Enumerate the likely consequences/impacts of Sea Level Rise on the coast*
4. *Suggest mitigation measures on water level and sea level changes*

Terms and Conditions

The University agrees to be bound by the standard terms which are valid for all users of MIKE Powered by DHI Software and which are described in the End User Licence Agreement, which is displayed during installation of all MIKE Powered by DHI software products. **The End User Licence Agreement forms an integral part of this Agreement.**

In addition, the University agrees to be bound by the terms specified below. These terms specifically limit the rights of the University to use the MIKE Powered by DHI Software and give DHI specific rights, should the University breach these additional terms.

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5. Any breach of this agreement will be prosecuted. The University is responsible for any violations.

I confirm that the User is a student at my institute working on the above-mentioned thesis, and I accept the Terms and Conditions as specified above on behalf of the University.

Date: 16-07-2020	
Supervisor name: **ARNAB SARMA**	Supervisor signature

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6. After finishing the thesis, User agrees to provide DHI with a digital copy (PDF format) of the thesis. At the same time, User agrees to provide DHI with a one-page abstract of the thesis that DHI may publish with due reference to the original text and with author information.

Hereby, I agree to fulfil all the conditions and responsibilities above.

Date: 16-07-2020	
User name: **SUDIPTA CHAKRABORTY**	User signature

List of Publications