



2021 Sea level rise projections by the Intergovernmental Panel on Climate Change for Coastal Design

James R Houston*

Director Emeritus, Engineer Research and Development Center, USA

***Corresponding author:** James R. Houston, Director Emeritus, Engineer Research and Development Center, USA.**Received Date:** September 13, 2021**Published Date:** October 11, 2021

Introduction

The Intergovernmental Panel on Climate Change (IPCC) delayed its normal six-year publication cycle of climate assessments after its Fifth Assessment Report (AR5) was published in 2013 [1] because there was an explosion of research on climate change that needed to be evaluated. IPCC's full Sixth Assessment Report (AR6) will be published in 2022. However, in August 2021, IPCC published the portion of AR6 [2] that deals with the physical basis for climate change including sea level rise. IPCC [2] was supported by updated projections of the contributions of Antarctica [3] and Greenland (The Ice Sheet Mass Balance Inter-Exercise 2020) to sea level rise. IPCC [2] has been peer reviewed extensively with the first draft receiving comments from 750 reviewers and the second draft

from 1279 peer reviewers [4]. IPCC [1] used temperatures that were projected for 2100 based on Representative Concentration Pathways (RCPs) that describe different climate-scenario futures. Scenario labelling is based on possible radiative forcing values by 2100. For example, RCP1.9 and RCP8.5 are scenarios with radiative forcing values in 2100 of 1.9 and 8.5 watts/m² respectively. Shared Socio-economic Pathways (SSPs) are the climate-scenario futures used in IPCC (2021a), but except for some minor differences relating to climate, SSPs are the same as RCPs. They were the same for sea level rise projections. Table 1 shows IPCC [2] projections to 2100 relative to sea level in 1995-2014. Projections are mean rises with parenthetical numbers representing standard deviations from the means (Table 1).

Table 1: Sea level rise projections for 2100 published in IPCC [2]. Projections are in meters.

Scenario	1.9	2.6	4.5	7	8.5
	0.38(0.28-0.55)	0.44(0.32-0.62)	0.56(0.44-0.76)	0.68(0.55-0.90)	0.77(0.63-1.01)

After eight years of study of climate change and sea level rise with a focus on sea level rise contributions from Antarctica and Greenland, the best science led to 2021 IPCC projections that are larger than IPCC [1] projections to 2100 by only 0.1-0.3 m. IPCC [2] introduced new two projections not in IPCC [1] that raise the possibility of sea level rises greater than those in Table 1. However, IPCC [2] notes that it has "low confidence" in both projections. One arises from a scenario called Marine Ice Cliff Instability (MICI) in which West Antarctic ice shelves disintegrate. IPCC [3] noted that only a single ice sheet model represents MICI [5] and "the validity

of MICI remains unproven" [2]. Moreover, a recent paper in Science [6] presents evidence that reduces further the chances of MICI. However, if MICI were to occur, IPCC [2] says it could raise sea level to 2100 by 0.99 m (0.82-1.19). The second low-confidence projection is based on a single Structured Expert Judgement (SEJ) survey [7]. Thirteen experts met in Washington DC and nine in London in 2018 and provided anonymous judgements on future sea level. Sea level contributions from Antarctica were key in their estimates of large rises by 2100. However, not one of the 22 were among the 67 Antarctic experts who projected sea level rise contributions

from Antarctica in IPCC [3]. IPCC [2] notes it has low confidence in SEJ projections because “individual experts participating in the SEJ study may have incorporated processes in whose quantification there is low confidence and the experts’ reasoning has not been examined in detail.” IPCC [2] gives SEJ projections of 1.00 (0.70-1.60) m. Some decisions relating to coastal projects have time horizons shorter than 2100. For example, beach nourishment

can be started, stopped, increased, or decreased quickly. IPCC [2] has projections to 2050 with mean values shown in Table 2. The projections are again relative to 1995-2014, which is centered in 2005. From 2005-2020 sea level rose 3.3 mm/yr, so to make the projections relative to about 2020, 0.04 m was subtracted from IPCC [2] results (Table 2).

Table 2: IPCC [2] projections from 2020-2050.

Scenario	1.9	2.6	4.5	7	8.5
2050	0.14(0.11-0.19)	0.15(0.12-0.21)	0.16(0.13-0.22)	0.18(0.14-0.23)	0.19(0.16-0.25)

Table 2 shows that mean rises from 2020 to 2050 vary from 0.14 to 0.19 m (5.5 to 7.5 in). That is, the difference in projections between the most benign (SSP 1.9) and worst-case (SSP 8.5) scenario is only 0.05 m (2 in). Even the “low confidence” projections have mean values only 0.01 m higher than the SSP8.5 value from 2020-2050. Rises do not depend greatly on scenarios until after at least 2050. Houston [8] noted that some U.S. agencies have sea level rise projections that differ among themselves and with the IPCC [1], leading to confusion, a lack of credibility, and an undercutting of the IPCC. The U.S. government was the driving force that formed the IPCC to produce climate reports backed by the world’s leading climate scientists [9]. U.S. agencies should rally around using IPCC [2] climate change projections, including sea level rise projections [10].

Acknowledgment

None.

Conflict of Interest

No conflict of interest.

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