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Uncertainties in predictions of climate change and sea level rise-a review

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ABSTRACT

The chronological development of the research methodologies on climate change and resultant sea level rise during the last two decades have been premeditated and it is found that the various assumed scenarios to apprehend the rise in global temperature have been grounded on lot of uncertainties. The real time data in climate change as well as sea level rise has been observed to be in variance from IPCC's estimated predictions. The gradual transition on the concept of emission pathway scenarios considered in SRES (2000) from the beginning of millennium till present concept of Representative Concentration Pathways (RCPs) in AR5 of IPCC has been referred. The scenario concepts in SRES (2000), being about 20 years old have gradually been modified and the scientific community now prefer modelling climate change based on RCPs (Representative Concentration Pathways). RCPs do not represent detailed socio-economic narratives or scenarios like that considered in SRES but pathways of radiative forcing. Radiative Forcing (RF) measures the capacity of a gas affecting the change in energy in the atmosphere due to GHG emissions. Unlike SRES, RCPs do not represent detailed socio-economic scenarios but Radiative Forcing, the capacity of a gas affecting the change in energy in the atmosphere due to GHG emissions. IPCC in its Fifth Assessment Report (AR5) considers four greenhouse gas concentration (not emissions) trajectories as Representative Concentration Pathways (RCPs) viz. RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5, considering possible range of radiative

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forcing values in 2100. However, in AR6 of IPCC, expected to come out in 2022, the scenarios are again likely to change during advent of CMIP6 and the variations in contributing factors in the form of Shared Socio-economic Pathways (SSPs). Particularly at present the melting of ice sheets at Antarctica and Greenland reportedly is going to a stage of no return and according to some school of thought of scientists self-sustained melting of the permafrost will linger. It is already proclaimed that even in a situation if all anthropogenic emission of GHGs is immediately stopped the self-sustained melting will continue. The models so far being based on numerical and probabilistic approaches are all drastically expected to undergo abrupt change because of the current icesheet dynamics at Antarctica and Greenland. Giving due weightage to deep uncertainty in sociopolitical and economic changes amongst nations, as well as the ice dynamics in present accelerated warming situation, while the importance of usability of model hierarchy for the complex science of climate change is stressed upon, the debate on uncertainty is acknowledged. The query remains whether the research on sea level rise is likely to take a new turn in the coming decades. Multidisciplinary approach to research with minimum uncertainty in a more precise and finer manner is called for.

1. Introduction

Nakicenovic, N. et al (2000) has evaluated at the beginning of the millennium how the world's climate will change in this century. It is acknowledged that the scientists resolved that the scenario will depend on how human societies would develop in terms of demographics and economic development, technological change, energy supply and demand, land use etc. The Intergovernmental Panel on Climate Change (IPCC) developed the global and regional emission pathways in its special report on emissions scenarios (SRES), considering four families of emission pathways, assuming a distinctly different storyline in the direction for future developments to make the each of the four storylines different in increasingly irreversible ways [1].

Meehl, G. A. et al. (2000) recorded the development of Coupled Model Intercomparison Projects for studying the output of coupled atmosphere-ocean general circulation models (GCMs) as standard experimental protocol named WGCM (the Working Group on Coupled Modelling). Under WCRP (World Climate Research Program), in

1995 CMIP (Coupled Model Intercomparison Projects) was established. The initial one was modified in 1996 as CMIP2 (1996) and revised to CMIP3 (2010), whereas, IPCC's Fifth Assessment Report (AR5) considered the model ensemble CMIP5 (2013) [2].

Rupakumar et al. (2006) observed that though it is difficult to clearly delineate the characteristics of climate change associated with natural and anthropogenic forcing due to complex interactions within the climate system human activities have led to unprecedented changes in the chemical composition of the earth's atmosphere. There are credible evidences to show that such changes have the potential to influence earth's climate. It is also stated that significant differences exist at regional levels in spite of the fact that meteorological data has recorded overall warming around the earth. Human activities like emission of greenhouse gases or land use changes result in external forcing. It is generally believed that external forcing induced climate change is predictable. But in reality, such predictions have limitations as population change, economic policy, technological changes are hardly accurately predictable. Because of the unpredictability itself climate projections are based on carefully constructed assumed scenarios. The authors cited an example that most models project enhanced precipitation during the monsoon season, particularly over the northwestern parts of India. However, the magnitudes of projected change differ considerably from one model to the other [3].

Mohamed EL SIOUFI (2010) while evaluating major challenges faced by cities and urban settlements in the coming decades under United Nations Human Settlement Programme (UN-HABITAT) from sustainability point of view observed that resulting sea level rise due to anthropogenically caused global warming is the largest challenge in our planet. It is pointed out that severe weather risk and sea water rise poses increasing threats in coastal areas. He indicated that threat to cities due to sea level rise is only one part whereas more extreme weather patterns such as intense storms are another [4].

Nathan Kettle (2012) exposed compounding uncertainties in Sea Level Rise Assessments and narrates that there are many barriers that impede adaptation to climate change, including lack of data, information, and resources; inflexible institutions; perceptions of risk; lack of funding and leadership; scale mismatches; and above all the uncertainty [5].

Levermanna et al. (2013) while assessing the multimillennial sea-level due to global warming explained that Antarctic Ice Sheet is by far the largest potential source for global sea-level rise under future warming conditions as it holds more than half of Earth's freshwater. that the melting ice in the Arctic does not raise sea levels, because the ice in question is sea ice, and it is already floating on the Arctic ocean. They also affirm that unless the current trend in rise global mean temperature is reversed the increasing Global mean sea level will continue to rise beyond the year 2100. It is established that sea level rise over the last century has been dominated by ocean warming and loss of glaciers. But sensitivity suggested important contributions should also be expected from the Greenland and Antarctic Ice Sheets. The rising trend of Global mean temperature may decline slowly due to inertia in climate and global carbon system, when greenhouse gas emissions will begin to cease. But uncertainty remains how much sea-level commitment is expected for different levels of global mean temperature increase. Additional strategies to better constrain the sea-level commitment will be necessitated [6].

Caron, David D et al. (2014) while formulating proposal to avoid conflict between sea level rise and the coming uncertainties specified that even as it is widely acknowledged that climate change will alter the world over the coming century, it is unclear how different regions of the globe will be affected by this change. No straight prediction is possible for some particular place, in terms of heat, precipitation. They however announced that in spite of the uncertainties two impacts are clearly known. The melting of the great ice sheets and glaciers will continue, and perhaps, melt even faster and the oceans will continue to rise over the next century in the order upto one meter. The effect of such rise in sea level will be felt around the world [7].

Chakraborty et al. (2014) while studying crop improvement observed that earth's climatic systems are one of the most dynamic and complex systems which still have not been properly understood. They acknowledged anthropogenic causes and noted the newer complexities in climate scenario because of its variation from the past. They stressed upon the need for clear distinction between climate change and global warming considering records through modern instrumentation, historical temperature analyses and global precipitation studies. It is stated that Climate and their elements no doubt are the most important determinants of all type of life forms on the earth, as evidenced by erratic precipitation, melting of glaciers, coral bleaching, tree line shifting including sea level rising [8].

Willem P. de Lange (2014) well documented various aspects on uncertainties in sea level change. They illustrated that global sea-level is estimated using averaged measurements from a worldwide network of coastal tide-gauges or from satellite-borne instruments. Being the worldwide average, it doesn't appear to be fruitful for local coastal evaluation. Rather local relative sea level measured at specific locations practically becomes more practical basis for coastal management. They also considered that depending upon the direction and rate of movement of the underlying land (tectonic change) in different parts of the world Local sea-levels are rising or falling and from geological evidence over long periods of time (millions of years) the sea level changes are inferred. According to them however these long-term changes suggest that any sea-level rises in response to temperature increases decelerate rather than accelerate over time. Based on past, it is stated with certainty at different locations around the world, future sea-level will continue to change at differing rates and in different directions. They mentioned two steps - understanding of past rates of change, present environmental conditions and theoretical analysis and projection of likely changes. Maximum rate and duration of natural sea-level rise is recorded to be about 30 mm/y over periods of a century and typically less than 10 mm/y – has been taking place over the last 10,000 y as slow global sea-level rise [9].

Trenberth KE et al. (2014) first stated there is an imbalance in energy flows in and out of the earth system. They stated that ''Warming'' being the phenomenon of extra energy can manifest in many ways like Rising surface temperatures, Melting Arctic sea ice, Increasing the water cycle and altering storms. The overall energy imbalance can be perturbed by changing clouds and albedo. The greenhouse gases increasingly trap more radiation and hence create warming and inferred most of the excess energy goes into the ocean. They focused on the need to monitor the energy imbalance with direct measurements to find where the energy goes and quantifying how climate change is manifested. They strongly opine key issues for Earth from an overall energy standpoint are the actual energy imbalance at the surface and top of atmosphere. They also agree 90% of the anthropogenic heat goes into the oceans and the remaining goes for melting both terrestrial and sea ice, while assessing the exchanges among the climate system components (atmosphere, ocean, land, and cryosphere) and the changes in phase especially of water involving latent energy (ice, liquid, and vapor). [10].

Unnikrishnan et. al (2016) documented the trends in Sea-level-rise based on estimates derived from satellite altimeter and tide-gauge data off the Indian coasts for the last two decades. From Altimeter data analysis during 1993–2012 period they noted that the rate of sea-level rise (3.2 mm yr.–1) is rather spatially homogeneous over most of the north Indian Ocean and close to global mean sea-level-rise trend in the same period. They also recorded the notable exception in the northern and eastern coasts of the Bay of Bengal, which experienced larger trends (5 mm yr.–1 and more). Finding the trends derived from altimeter data as higher than those estimated from tide-gauge records over longer periods they targeted for an improved understanding of the mechanisms behind this accelerated sea-level-rise recorded over the past two decades. The nonconformity was highlighted as uncertainties between the methods of measurement. They opined that the modelling concepts may land up afresh depending on how the melt water react with unforeseen atmospheric changes. They considered lack of long sea-level observations is a major caveat to derive the reliable multidecadal sea-level rise, at Indian Ocean, because Satellite altimetry provides high-resolution sea-level measurements since 1992 but inadequate for reliable estimates of regional sea-level rise trends [11].

Gonéri Le Cozannet et al. (2015) during evaluating uncertainties on flooding due to rise of sea-level observed that frequency of coastal flooding events has changed. They highlighted the need for accounting variability of sea-level rise and storm surge patterns to provide quantitative insight into the relative importance of contributing uncertainties over the coming decades accurately. Considering IPCC projections for sea level rise, a global sensitivity analysis was applied on an urban low-lying coastal site located in the north-western Mediterranean, where the yearly probability of damaging flooding could drastically grow after 2050 [12].

Sorokin Lionid et al., (2015) while investigating on European Airports reiterated their concern about radical uncertainties in Sea Level Rise. The importance of climate scientists' divergent opinions about the sea level rise and its consequences for decision-takers was highlighted. The team opined that new scientific uncertainties on SLR's evolution essentially meant lack of reliable scientific knowledge which in turn is linked with the decision-makers' liability resulting from scientific uncertainty. Considering baseline scenarios in IPCC AR5 for increase in global mean surface temperature without additional mitigation, they called for internationally synchronized fast mitigation and prevention measures to combat with the detrimental situation [13].

Oddo. C. Perry et. al. (2017) stressed upon the hypothesis of Decision Making under Deep uncertainties in sea-level rise and storm surge projections for risk analysis from the point of view of Operations Research. They stated that flood adaptation model produces potentially myopic solutions when formulated using traditional mean-centric decision theory as the risk- based adaptation strategies remain silent on certain potentially important uncertainties. They explained the concept of 'Deep uncertainty' as a condition in which analysts cannot correctly anticipate: (1) the appropriate models for interactions amongst variables, (2) the probability distributions and/or (3) the desirability of alternative outcomes. They found deep structural uncertainties that have large effects on the model outcome, with the storm surge parameters accounting for the greatest impacts. Global sensitivity analysis effectively identifies important parameter interactions that local methods overlook, which could have critical implications for flood adaptation strategies [14].

Baker Alexander et. al. (2017) categorically highlighted that uncertainties surrounding contribution of the West Antarctic ice sheet to future sea-level projections may be much larger than typically perceived. They reckoned that the West Antarctic ice sheet (WAIS) is going through rapid disintegration and also noted published projections as widely divergent. To quantify the deeply uncertain contributions from West Antarctic Ice Sheets, they presented a set of probabilistic semi-empirical models of the climate and sea-level contributions from thermal expansion alongwith contributions from the Antarctic ice sheet, the Greenland ice sheet, the glaciers and the small ice caps. Three projections based on three WAIS-collapse scenarios, following RCP8.5; no collapse (0 cm), a mid-range estimate (79 cm in 2100) and a high case (3.3 m, full WAIS disintegration within a couple decades) were considered. In the case of sea-level projections, they found a high range of deep uncertainty (Figure 1) as the range usually involves both a probabilistic interpretation of the surrounding uncertainties and the estimates.

The projections were designed to highlight the relatively large deep uncertainties, particularly those resulting from future climate forcings4 and those surrounding potential WAIS collapse. It was stated by them that the future climate forcing is, to a large extent, controlled by future human decisions [15].

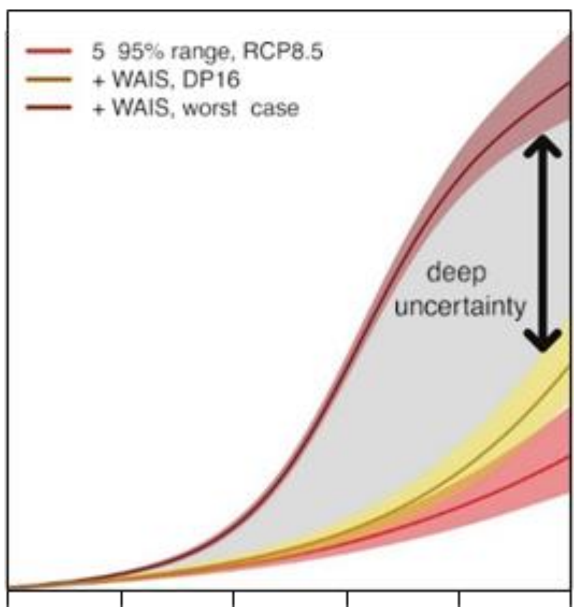

Figure 1. Future sea-level projections including deeply uncertain contribution of the WAIS

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Katharine J. Mach et. al. (2017) taking stock of recent advances and challenges in ‘Next Generation of Assessment’ acknowledged deep uncertainty and reviewed the climate change assessment. They relied upon quantitative/qualitative evidences, expert judgements, exploring futures and interactions between experts and decision makers. They opined that in current era of climate and broader global change, integrative assessment considering consider both opportunities and pitfalls can bolster decisions about uncertain futures for sustainability. The need for integrative assessment is identified to enlist what is known and what is not [16].

Garner et al. stated (2018) came out with the fact that the upper projection windows for the SLR projections are not uniform across different studies. They opined that in reality very often future SLR remains deeply uncertain. Projections of SLR from individual studies varies from one another and rather generally found higher than the upper projections, anticipated by the Intergovernmental Panel on Climate Change. It is expressed that the accuracy of the research outputs remains ambiguous. The widely varying range of the projections reflects gaps in scientific knowledge about the processes that contribute to SLR. They categorically raised doubts and distrusted the correctness of the research outputs. The widely varying range of these projections reflected gaps in scientific knowledge about the processes that contribute to SLR, reflected in assumptions used to produce projections [17].

Le Bars Dewi. (2018) explained that the uncertainty of total sea level projections obtained by adding the contributions from thermal expansion, glaciers, and ice sheets', depends on the correlation between the uncertainties of the contributing factors. In an attempt to model the correlation structure and its time dependence, they observed that the correlation primarily arises from uncertainty of future global mean surface temperature which predominantly correlates with almost all contributors. They acknowledged the acceleration of the sea level rise in this century. However, they mentioned that unfortunately numerical models, based on a physical understanding of the relevant processes of the complex systems like the Earth's climate, do not yet include all of the important processes driving future sea level. It is highlighted that glaciers and ice caps are large enough to contribute to sea level rise, but the main physical processes determining their response to climate change are still uncertain. The long-time scale of adjustment and sensitivity to small circulation and temperature biases still make it challenging to include them in fully coupled models. The problem of dependence of sea level contributors is also more difficult to understand because it is not about events that correlate in time, for which we have a good intuition, but about events that correlate in the ensemble of possible futures that is a more abstract concept [18].

Mehta et.al. (2019) introduced the heuristic of the 'above', 'middle' and 'below' to understand the uncertainty perspectives on climate change in Indian perspective. They studied sea level rise at three places viz. Kutch, The Sundarbans and Mumbai and referred the cataclysmic flooding over Mumbai on July 2005 due to about 944 mm of rain poured within 24 hours. It has been expressed that there is now a growing acknowledgement that climate science is dealing with uncertainties arising due to macro trends such as temperature extremes and sea level rise. They hardly appreciated understanding the effects at the local level due to downscaling challenges and also intersections with other drivers of change. They emphasized on the 'envelope of uncertainty' that intersects with social, political, economic, cultural and scientific domains and called the 'Debates of uncertainty in climate change' as a 'super wicked' problem for scientists [19].

Kopp et. al. (2019) while evaluating the usability of recent researches, identified that Sea-level rise involves natural and human systems with long lags, irreversible losses and deep uncertainty in anthropogenic emissions, ice sheet dynamics, variability in tides and storms. They opined that given the political, economic, and technological complexities involved, there is no sacrosanct way of estimating the relative probability of different future emissions. Accounting for deep uncertainty involves interactions of sea-level change, geomorphology, socioeconomics, human responses, risk management, adaptation strategies, political and economic viability etc. The usability of sea-level science being a pressing concern, it requires grappling with deep uncertainty in long-term sea-level projections, the relationship between long-term trends and the impacts of short-lived extreme events, and the ways in which the physical coast respond to increasingly frequent flooding. It is also stated that it requires more extensive engagement of the scientific process, as well as cognizance of the political economy of linking stakeholder-engaged science to action [20].

Kopp et al. (2019) for managing the risks of sea level rise, explained in details about the two increasingly well understood forms of ice-sheet instability i.e., Marine Ice Sheet Instability (MISI) and Marine Ice Cliff Instability (MICI). Because of limited scientific agreement on the key conceptual models, they mentioned 'Deep Uncertainty' to be same as 'Ambiguity'. The inherent uncertainties related to impacts of sea-level rise obtained from Probabilistic Approaches, Dynamic Ocean Circulation Model, Bathtub model for inundation has been discoursed. Interestingly, the extent of uncertainty has been explained by equating it with gambling. For illustrating the implication, it has been commented that in general, all else being equal, humans exhibit a preference for the less ambiguous gamble [21].

Thomas Slater et al. very recently (2020) came out with the finding that driven by ice dynamics in Antarctica and surface melting in Greenland, the ice-sheet losses track with the upper range of the IPCC Fifth Assessment Report sea-level predictions. They impressed that short-term variability in the atmosphere, oceans and climate must be accounted in the Ice-sheet models for accurately predicting sea-level rise. They mentioned that Ice dynamic contributions were derived from ice-sheet models forced by, but not coupled to, atmospheric and oceanic model outputs. In this way, the atmosphere and ocean can impact the ice sheet but not vice versa. Advances in ice-sheet modelling are expected in 2022 through Ice-sheet Model Intercomparison project for CMIP6 (ISMIP6), which will deliver process-based projections forced by output from coupled atmosphere–ocean GCMs in AR6 of IPCC report [22].

Garbe et al. recently (2020) documented the hysteresis of the Antarctic Ice Sheet mentioning that a comprehensive stability analysis of the Antarctic Ice Sheet for different amounts of global warming was not available so far and they found that Antarctic Ice Sheet exhibits thresholds, on multitude of temperature, beyond which ice loss is irreversible. They observed that the ice sheet's temperature sensitivity is 1.3 meters of sea-level equivalent per degree of warming up to 2 degrees above pre-industrial levels. Between 2 and 6 degrees this will almost double to 2.4 meters per degree of warming and for per degree of warming between 6 and 9 degrees would increase to about 10 meters. More than half of Earth's freshwater resources are held by the Antarctic Ice Sheet which comprises an ice mass equivalent to 58 m of global sea-level rise. Its future evolution and the associated sea-level change are therefore of profound importance to coastal entity ecosystems and economies. The long-term stability of the Antarctic Ice Sheet under a changing climate is the subject of ongoing research. It will be determined by the interplay between a number of negative (dampening) and positive (amplifying) feedback Mass loss from the Antarctic Ice Sheet constitutes the largest uncertainty in projections of future sea-level rise [23].

Rander et.al. (2020) also iterated that the seriousness of the risk of climate change are too dangerous to be disregarded. They reported their findings from their new climate model ESCIMO that the world is already past a point of no return for global warming. They observed that self-sustained melting of the permafrost will continue for hundreds of years, even if global society stops all emissions of man-made GHGs immediately. That stated that melting (in ESCIMO) is the result of a continuing self-sustained rise in the global temperature as an effect of warming which is the combined effect of physical processes viz. melting of the Arctic ice, increase of water vapour in the atmosphere (driven by higher temperatures), and variation of concentrations of the GHG in the atmosphere. They have categorically mentioned that enormous amounts of CO2 have to be extracted from the atmosphere to stopover the self-sustained warming. They stated that rise in the amount of water vapour in the atmosphere and further rise in the temperature which causes increased release of carbon from melting permafrost are due to anthropogenic causes. At this juncture in plain language, it means that 'There is nothing we can do to stop the oncoming effects of climate change' [24].

Penelope Maher et al. (2020) emphasized on the importance of model hierarchies for understanding atmospheric circulation. It is clarified that there is no single unique hierarchy and no one model is suitable for all purposes. A suitable model hierarchy needs to be constructed based on the key scientific questions of interest and even for a given scientific problem, individual scientists will make different, perhaps equally defensible, choices. Their confidence in global warming projections does not yield from blind faith in GCMs output; rather fundamentally supported by basic physical laws. However, those laws have little quantitative predictive capability for Earth's climate. At the other extreme, when comprehensive models are forced into the warmer regimes that may lie in our planet's future, comparing parametrizations is difficult. They suggested purpose of the model hierarchy is to provide a pathway connecting robust physical laws to complex reality. Even they declared debates remain if all models are wrong and only a few are useful [25].

Haasnoot et al. (2020) narrated about the large uncertainty on how potential ice-mass loss from Antarctic large can rapidly contribute to sea level rise in the second half of the century. They also explained the impact of sea level rise from the said ice-mass loss on the coastal adaptation strategy of the low-lying country like The Netherlands. As sea levels rise faster and higher, they forecast that sand nourishment volumes to maintain the Dutch coast in 2100, may increase 20 times larger than to date. The world-renowned storm surge barriers will need to close at increasing frequency until closed permanently. Intensified saltwater intrusion will reduce freshwater availability while the demand will be rising. Anticipating deep uncertainty, they inferred that high SLR scenarios helps to enable timely adaptation and to appreciate the value of emission reduction and monitoring of the Antarctica contribution to SLR [26].

Frank Pattyn et al. (2020) after studying the uncertain future of the Antarctic Ice Sheet published their view that The Antarctic Ice Sheet is losing mass at an accelerating pace, and ice loss will likely to continue over the coming decades and centuries. Some regions of the ice sheet may reach a tipping point, potentially leading to rates of sea level rise at least an order of magnitude larger than those observed now. For unmitigated scenarios they expressed their concern on the uncertainty about how fast and how much Antarctica will contribute to sea level rise. They also mentioned the role of the bed bathymetry and relation between global warming ocean dynamics. They felt that because of uncertainty only, linear extrapolations of present-day observed melt rates or simple parameterizations of ice-ocean melting rates are generally applied, mostly focusing on unmitigated climate scenarios, such as Representative Concentration Pathway (RCP) 8.5. To assess the accuracy in the representation of physical processes in current ice sheet models they suggested to organize large international intercomparison projects [27]

Jonathan M. Gregory et al. (2020) studied the evolution of the Greenland ice sheet under a range of constant climates (typical of those projected for the end of the present century) using a dynamical ice sheet model coupled to an atmosphere general circulation model and found irreversible large future decline of the Greenland ice sheet. They studied the multimillennial future evolution of the Greenland ice sheet for various magnitudes of anthropogenic climate change in experiments with constant climates using an AGCM interactively coupled to a dynamic ice sheet model. They also pointed out snow albedo as a particularly important uncertainty considering that removal of the ice sheet is reversible with highest choice of albedo [28].

Benjamin Horton et al. (2020) very recently documented the variability of global mean sea-level (GMSL) projections obtained from various studies and observed that considering the same emissions scenario has led to confusion amongst decision-making communities. They noted that 106 experts projected a likely (central 66% probability) GMSL rise of 0.30–0.65 m by 2100 relative to 1986–2005 under Representative Concentration Pathway (RCP) 2.6 and 0.54–2.15 m by 2300. It is opined that knowledge of the uncertainties related to sea level rise are vital to make informed mitigation and adaptation decisions. The same experts projected a likely GMSL rise of 0.63–1.32 m by 2100, and 1.67–5.61 m by 2300 under RCP 8.5. The Antarctic and Greenland Ice Sheets being the largest potential contributors to GMSL rise, experts who identified the Antarctic Ice Sheet as the greatest source of uncertainty account for 23% of responses for 2100 and 21% for 2300. They invited the experts to state what their greatest source of uncertainty was for their estimates for 2100 and 2300 under both RCP 2.6 and RCP 8.5. They categorically decided to use open-ended questions to avoid biases in influencing respondents' opinion about their sources of uncertainty and resources regarding sea-level rise estimates. The responses for sources of uncertainty were placed into four main categories: (1) ice-sheet uncertainty, (2) anthropogenic uncertainty, (3) model/data limitations, and (4) ocean-atmosphere uncertainty. [29].

Conclusion and discussions:

From the foregoing collection of information from randomly selected scientific papers published in last two decades, it is concluded that deep uncertainties remain in the research of climate change and the resultant sea level rise. Climate Science being undoubtedly a very complex multidisciplinary subject, varying reports from different schools of thought of groups of scientists and their considered models has reestablished the uncertainty to a great extent (Horton et al.2000). While the entire planet is under threat the seriousness of the risk of climate change are certainly too dangerous to be disregarded. Because of accelerated melting in Antarctica and Greenland although some model (Rander et al. 2020) pessimistically opines ‘There is nothing we can do to stop the oncoming effects of climate change”; the debates remain if all models are wrong and only a few are useful (Maher et al. 2020). From the chronology of emission scenarios considered in SRES to RCPs in AR5 and further upcoming transition to SSPs in AR6, alongwith the advent of CMIP6 and also the current scenario of fast melting of icesheets at Antarctica and Greenland reaffirms the complexity and uncertainties. Such unresolved uncertainties raise a question whether the research on sea level rise is going to take a new turn in the ensuing decade starting from 2021. Despite the axiom that climate change is number one threat to global population, most recent media publications highlights ups and downs in control on gigatons of carbon di oxide. The researchers say production of coal, oil and gas must fall by 6% a year to keep global heating under target agreed in the Paris accord until 2030. But nations are planning for production increases of 2% a year and G20 countries are giving 50% more coronavirus recovery funding to fossil fuels than to clean energy. Fact remains that world is doubling on fossil fuel; Great Barrier Coral Reef is deteriorating from World Heritage. Uncertainties in ocean circulation models, barotropic vorticity, escalating heat call for more finer precise research to arrive at an optimized adaptation strategy. It is hoped that some clue for newer research approaches may be obtained from AR6 of IPCC.

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