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PROBABILISTIC THREATS FOR COASTAL REGIONS DUE TO THE GLOBAL WARMING PHENOMENA

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Abstract: Climate change is a big problem these days. The earth is becoming increasingly heated due to many human activities. Climate change, or global warming, is the end effect. Raising atmospheric temperatures lead to an increase in sea level, Impacting Global deltas and low-lying coastal regions. Based on current estimates, which project a range of uncertainty from 2.2 to 4.9°C, emissions of greenhouse gases are predicted to result in a global average temperature increase of approximately 3.3°C by the conclusion of the next century. This warming is expected to influence sea levels significantly will increase as a result of thermal expansion and ice melting as temperatures rise. Based on available secondary data, this research examines how climate change-related sea level rise affects Libya's coastal zone. Coastal areas are important for both ecology and socioeconomics references. The materials emphasize challenges connected to sea level rise in coastal nations and include international studies, scholarly publications, maps, and news items. The work also took into account several research in the same subject conducted in other regions of the world. The study looks for both qualitative and quantitative effects in addition to trying to identify potential solutions that might aid with issue adaptation. The primary driver of global warming is climate change, as evidenced by the study's assessment of sea level rise and the surrounding debate.

Keywords: Climatic change, Coastal areas, Global warming, Sea level.

Introduction

At the moment, Earth is experiencing an energy imbalance, which is defined as the planet taking in more solar energy from the Sun than it is returning to space. The estimated energy imbalance is about one W/m2, which is not much compared to the 342 W/m2 that the Sun delivers, but it is still a significant amount that might change the Earth's climate drastically. The predominant factor contributing to this energy imbalance is the widely recognized emission of greenhouse gases (GHGs). Primarily driven by human activity, the release of greenhouse gases into the atmosphere is largely a result of burning fossil fuels and altering land use, notably through deforestation. During the 2009–2018 decade, emissions of CO_2 equivalent were mostly caused by deforestation (5.5 Gt/year) and fossil fuels (37.5 Gt/year).

The oceans and vegetation are the two main sinks of CO2, taking in 29% and 23% of it respectively, thus only 44% of the gas released has remained in the atmosphere. On the other hand, acidification of seawater is a drawback of the ocean sink and might have catastrophic effects on marine life and entire marine ecosystems. In 2019, the amount of CO2 in the atmosphere reached 410 parts per million (ppm), 40% more than the Earth has witnessed in the preceding 800,000 years (Figure 1). From a human standpoint, the coastal zone, which is the meeting point of land and water, is one of the most significant regions of the world's seas. Coastal marine ecosystems, which include estuaries, sea grass beds, salt marshes, tidal flats, mangroves, coral reefs and shelves [1] Atmospheric deposition and groundwater transportation are of growing importance, together accounting for 20%-50% of total exogenous loading among accelerating nitrogen inputs [2].

Industrial development has altered, disturbed and destroyed coastal ecosystems, including sensitive habitats. Many important industrial centres are situated on estuaries and in the vicinity of urban areas and ports [3].

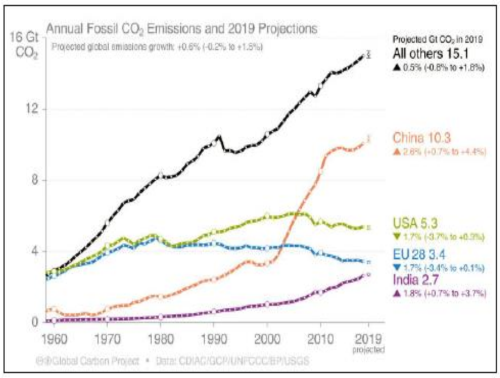

Fig. 1: GHG emissions by region since 1960 (in Gt/year equivalent CO2) (source: The Global Carbon Budget project, 2019).

The graph in Figure 2 depicts the rising global mean sea level (GMSL), which is rising more quickly than it did previously. 3.25 +/- 0.3 mm/year is the average annual growth rate from 1993 to 2020. The acceleration of 0.1 mm/year2 is expected. One to two centimeters is now the precision limit for sea surface height measurements, thanks to advancements in precision. This improvement makes it possible to measure the average rate of sea level rise to within about 0.3 mm of year. This level of precision is confirmed by validations using tide gauge comparisons and thorough analysis of probable error factors affecting the altimetry system.

Regional sea level rise tracking is made possible by satellite altimetry's nearly worldwide coverage of the oceans. This is illustrated in Figure 3. A factor of two or three separates sea level increase in some locations from the global mean. Southern oceans and the tropical Pacifics to the north and west are particularly good examples of this.

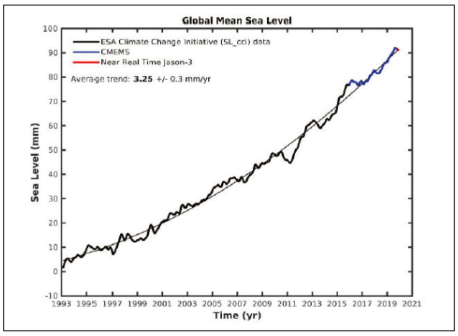

Fig. 2: Evolution of the global mean sea level from January 1993 to May 2020, as measured by satellite altimetry data provided by LEGOS.

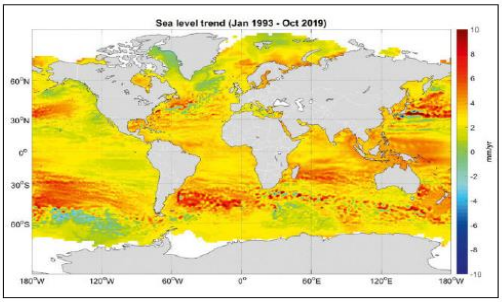

Fig. 3: Satellite altimetry data on sea level trends from 1993 to 2019 (source: LEGOS).

Anthropogenic warming is predicted to cause a faster rise in sea level in the 21st century, with a minimum rise of 10 cm recorded in the 20th century. Sea levels are predicted to rise between 9 cm and 88 cm between 1990 and 2100, with a median prediction of roughly 48 cm, according to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Sea levels will inevitably rise significantly beyond this century if climate change is allowed to continue unchecked. This much is becoming obvious. Notably, the principal sources of this elevation are probably going to come from both Greenland and Antarctica. In addition, even though it is now thought to be extremely unlikely, should global warming continue unchecked, there is a growing chance of significant sea level rises that are directly linked to possible instability within the West Antarctic Ice Shelf [5, 6].

The impact of rising sea levels will primarily affect coastal areas; however, the implications extend far beyond immediate geographical changes due solely to high concentrations of natural resources and socioeconomic assets within these regions. Coastal zones hold critical importance not only as hubs for human habitation and economic activities but also possess considerable ecological significance [7], [8].

As per estimates reported in 1990, approximately 1.2 billion people about 23% of Earth's population at that time—resided close proximity fro coastlines containing population densities nearly threefold higher than the global average [9, 10]. In the near-coastal zone, population density likewise rises seaward; below 20 meters, concentrations are at their maximum. Furthermore, because of net coastal migration, it is commonly believed that coastal populations are rising faster than the world mean. Urbanization is a significant trend; in 2010, there are expected to be 20 major coastal cities with populations over 8 million, in addition to several smaller towns and cities grouped around the coast [7, 8]. Human vulnerability to sea level rise is therefore substantial and increasing.

2. OBJECTIVE OF STUDY

This overview examines the possible effects of human-induced sea level rise within the framework of the emerging coastal system. To start, the vast time scales involved with this issue are illustrated by taking into account the observed and anticipated fluctuations in sea level throughout the course of the 20th and 21st centuries and beyond. This takes into account how mitigation affects sea level rise. Next, a suitable conceptual framework for evaluating the effects of sea level rise is introduced and explored.

3. SEA-LEVEL AND CLIMATE CHANGE IN COASTAL AREAS

3.1 Sea-Level Change Components

The term "relative sea-level change" refers to the local fluctuations in sea level at coastal areas, which are influenced by a combination of global, regional, and local factors [12, 13]. Consequently, a uniform rise in sea level worldwide does not necessarily indicate a change in the global mean sea level. The variability in relative sea level over varying time periods is influenced by multiple factors. During the significant time span of human concern (102–103 years), relative sea level is affected by the following:

1. Rise in global mean sea level due to an increase in the overall volume of the ocean, primarily driven by thermal expansion of the upper ocean as well as the melting of small ice caps linked to human-induced global warming. 20th and 21st [5].
2. Geospatial differences in thermal expansion impacts, alterations to long-term wind patterns and atmospheric pressure, and shifts in ocean circulation patterns such as the Gulf Stream are instances of local meteo-oceanographic factors [14, 15].
3. Vertical land motion caused by tectonics, neotectonics, glacial-isostatic adjustment (GIA2), and

compaction, among other geological phenomena [16, 11].

3.2 Recent Sea-Level Trends

The 19th century data in Figure 4 suggests that sea level rise occurred more quickly in the 20th century than it did in the 18th and 19th centuries [5, 18]. The date of this little acceleration points to the end of the "Little Ice Age" as its likely cause, excluding alterations brought about by humans. Sea levels are thought to have increased 10–20 cm globally throughout the course of the 20th century, although there is no indication of acceleration [2]. Since then, it has been claimed that the estimate that best fits the facts at hand is one that is based on a 20-cm rise throughout the 20th century [19]. Consequently, the 20th century saw a notable rise in sea level, which has undoubtedly been a stressor leading to several of the current issues with the shore.

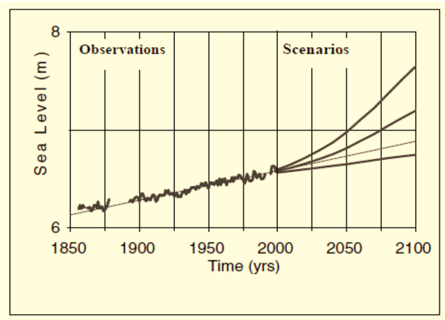

Fig. 4: The SRES sea-level scenarios provide projections for New York City from 1850 to 2100, detailing relative increases in sea level over the specified period.

3.3 Future Sea-Level Scenarios

The projected rise in global sea levels from 1990 to 2100, with an intermediate estimation of approximately 48 cm, is derived from greenhouse gas emission scenarios outlined in the Special Report on Emission Scenarios (SRES).[19]. Although this prediction is a little less than that of the second IPCC assessment [20], there is still a wide range of uncertainty regarding projected global mean increase. There are two separate causes for these uncertainties:

1. Uncertainties about the quantities of greenhouse gases in the future; and
2. Uncertainties regarding the climate's reaction to a greenhouse forcing (the climate and the sensitivity to sea level rise).

Detailed sea-level rise forecasts after 2100 are less studied, although depending on the extent of global warming, a substantial extra rise would be anticipated. As seen by the rise in ocean heat content in Figure 5, the data on ocean temperatures gathered over a few decades have unequivocally demonstrated that the seas are warming.

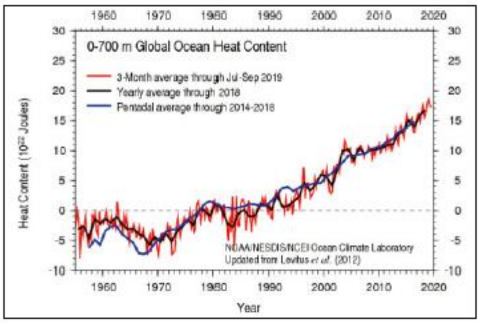

Fig. 5: ocean's temperature since 1955 (source: 2019 State of the Global Climate report, WMO [4]

The GRACE satellite data clearly demonstrates direct measurements of ice sheet mass variations across Greenland and Antarctica. Notably, both Greenland and West Antarctica are experiencing an accelerated rate of mass loss, which is effectively illustrated in Figure 6.

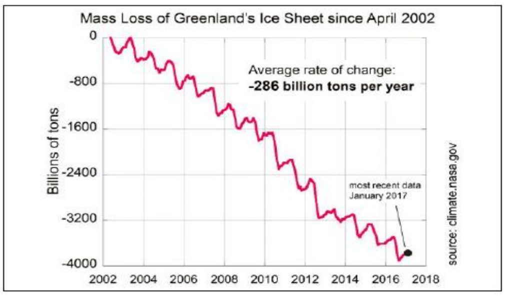

Fig. 6: The mass of the Greenland ice sheet is experiencing a measurable reduction, according to data from NASA.

Figure 7 presents a comparative analysis of the globally measured mean sea level from 1993 to the current date. The annual residuals have consistently remained below 2 mm. In terms of trends, it is important to note that since 2005, the deviation in the sea level budget has been confined to less than 0.3 mm per year, a figure that aligns closely with the uncertainty associated with mean sea level rise measurements.

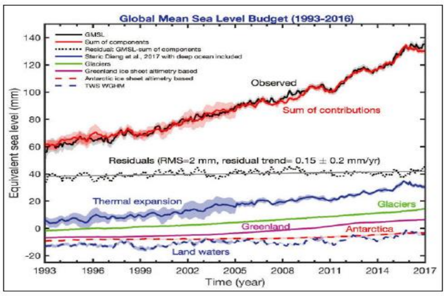

Fig. 7: Budget for sea level between 1993 and 2016. (Source: ESA Sea Level Budget Closure Project 2019).

4. IMPACTS OF SEA-LEVEL RISE

The natural-system consequences of sea level rise have a variety of possible socio economic repercussions [13], some of which have been noted by McLean et al. [22]:

1. A rise in the destruction of land and coastal environments
2. A higher chance of flooding and maybe fatalities
3. Deterioration of other infrastructure and coastal defense projects
4. Depletion of resources used for sustenance and renewal
5. Loss of leisure, tourist, and transit opportunities
6. Loss of cultural resources and values that is not monetary
7. The effects of declining soil and water quality on aquaculture and agriculture.

4.1 National-Scale Assessments

Table 1 show that, assuming no human adaptive response, a 1-meter rise in sea level would affect approximately 180 million people. The national-scale evaluations that are now available often consist of inventory of the possible effects of a one-meter rise in the level of the sea, with little attention paid to adaptation [21, 23]. Rise in sea level adaptation may reduce the real sensitivity of coastal wetlands, which may be much lower, than the research' imprecise effect assumptions [24]. Nevertheless, the wetlands appear to be at grave risk.

Table 1: Consolidated findings from national surveys

.Country	People Affected		Land At Loss		Wetland At Loss
	#People (1000s)	% Total	Km²	% Total	Km²
Antigua	38	50	5	1.0	3
Argentina	-	-	3400	0.1	1100
Bangladesh	71000	60	25000	17.5	5800
Belize	70	35	1900	8.4	-
Benin	1350	25	230	0.2	85
China	72000	7	35000	-	-
Egypt	4700	9	5800	1.0	-
Guyana	600	80	2400	1.1	500
Japan	15400	15	2300	2.4	-
Kiribati	9	100	4	12.5	-
Malaysia	-	-	7000	2.1	6,000
Marshall I.	20	100	9	80	-
Mauritius	3	<1	5	0.3	-
Netherlands	10000	67	2165	5.9	642
Nigeria	3200	4	18600	2.0	16000
Poland	235	1	1700	0.5	36

Senegal	110	>1	6100	3.1	6000
St Kitts	-	-	1	1.4	1
Tonga	30	47	7	2.9	-
Uruguay	13	<1	96	0.1	23
U.S.A.	-	-	31600	0.3	17000
Venezuela	56	<1	5700	0.6	5600
TOTAL	178834		149022		58790

Regarding the impacts of sea-level rise, numerous potential effects are highlighted (refer to Figure 8). Proactive adaptation strategies can effectively mitigate these anticipated impacts.

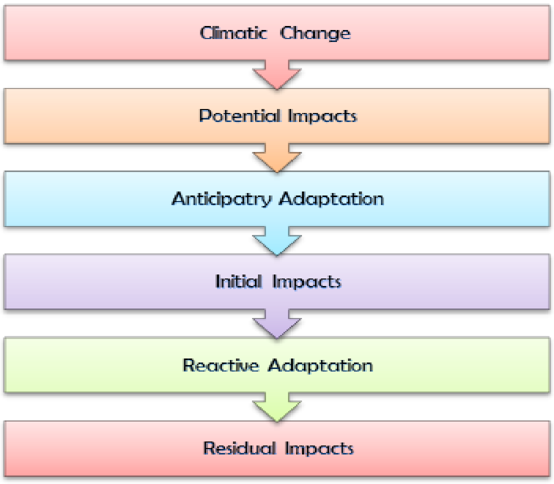

Fig. 11: Illustrates the impacts of climate change and rising sea levels.

5. DISCUSSION

The information that came before it has demonstrated that there is a significant potential for influence on both natural and human systems (e.g., floods and wetland loss). The increase in global mean sea level is a well-established consequence of global warming. This rise presents several significant implications, including: (1) heightened risk of flooding and increased submergence; (2) salinization of surface and groundwater resources; and (3) morphological changes, notably erosion and the degradation of wetlands.

Although these implications have all been evaluated in different ways, the integrated evaluations that will be most helpful to policymakers are not as advanced. It is important for policymakers to remember that the outcome of any assessment is contingent upon the assessment's size and the specific techniques employed. As such, it is necessary to align policy issues and their formulation with the proper assessment level. Compared to effects that depend on the pace of sea level rise (such wetland loss and change), this is especially significant for effects that depend on the absolute rise in sea level, like floods. The best course of action for coastal areas in response to climate change would be to combine adaptation and mitigation, based on the information currently available. As a result, in order to create the most effective policy combinations for climate change in coastal areas, mitigation and adaptation strategies must be evaluated together and holistically. A few countries that have seen sea level rise as a result of climate change and global warming are listed in Table 2. Egypt is one of these, sharing many geological and geomorphological traits with Libya.

6. CONCLUSION

In the light of the previous The following inferences can be made:

1. Sea level rise offers compelling evidence of climate change, driven by factors such as ocean warming, the melting of land-based ice, and alterations in water storage across continental river basins.
2. Currently, sea levels are escalating at a sustained pace exceeding 3 mm per year, with indications that this rate is accelerating.

3. It is projected that sea level rise will persist into the future and for centuries to come due to ongoing global warming expected over several decades, impacting many coastal regions worldwide.
4. Monitoring sea level fluctuations and understanding the contributing factors remain critical priorities in climate change research to enhance the accuracy of sea level predictions on both global and local scales. The observations emphasize that the majority of coastal zones become threated due to the climatic changes and sea level rising.
5. Libya is one of countries that have been threatened by changing in sea levels due to climatic changes because of the majority of population are concentrated along the coastal zone.

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