# *Causes and consequences of rising sea levels: should the global community be concerned?*

Júlia Eduarda Gouveia Rabelo de Abreu

Climate change is affecting the world in different ways. Looking at a multifaceted problem, it is possible to discuss multiple variables such as land use, acidification of the oceans, degradation, loss of biodiversity, air pollution, heat waves, droughts, water scarcity, and the sea level rise within the context of climate change. All of these matters should be considered as environmental reactions, due to the accelerating process of global warming.

The greenhouse effect is a natural phenomenon, maintained by the greenhouse gases – carbon dioxide ($CO^2$), water vapor, and methane (CH4), which allows the temperature of the Earth's atmosphere to be stable (WHAT..., 2020). Human activities began to intervene in the stability of greenhouse gas levels over the years. This is due to the gases released by industrial activities, which are large emitters of methane and carbon dioxide, in addition to other air pollutants. One of the main activities that allow these emissions is burning fossil fuels, such as oil and coal. By emitting more greenhouse gases, more heat will be absorbed into the atmosphere, generating an increase in global temperature. Therefore, climate change is a modification in ecosystem levels, directly related to a higher concentration of heat in the atmosphere that unbalances environmental stability. Thus, "the end of environmental stability means that concepts of threat and security need to be updated" (VIOLA; BASSO, 2016, p.1).

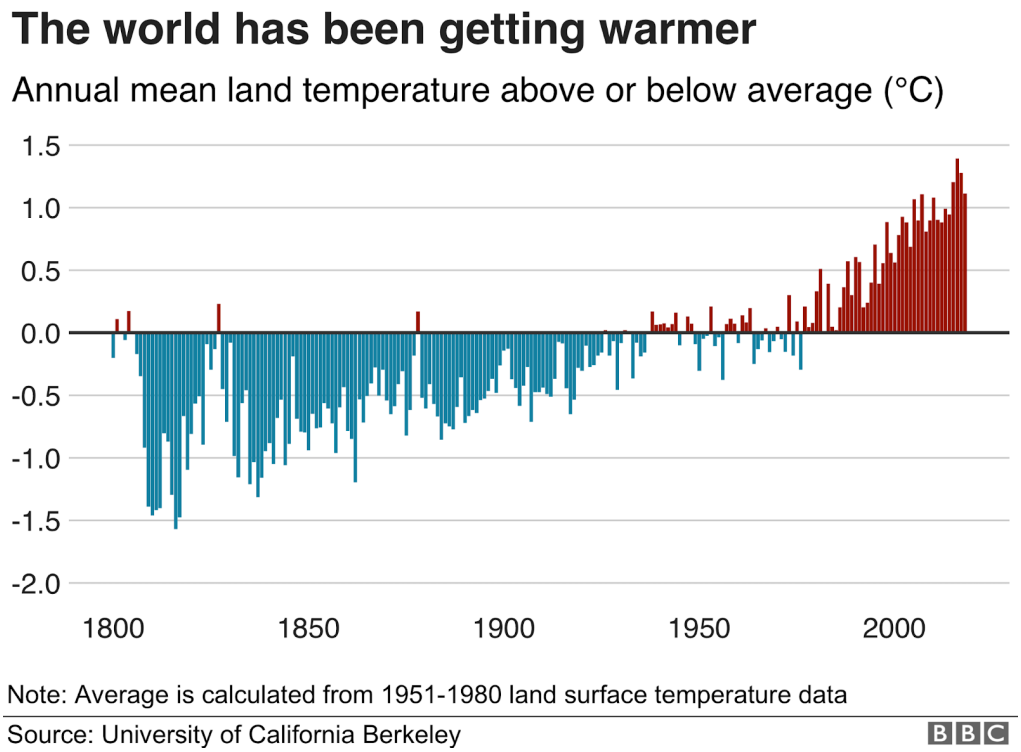
As one of the elements of the ecosystem, the oceans are deeply affected by these changes. In a better reasoned explanation, one of the consequences of climate change is that global warming

> "[...]increases in the height of the sea with respect to a specific point on land. Eustatic sea level rise is an increase in global average sea level brought about by an increase in the volume of the ocean as a result of the melting of land-based glaciers and ice sheets. Steric sea level rise is an increase in the height of the sea induced by changes in water density as a result of the heating of the ocean." (RIGAUD, 2018, p.10)

The causes of global mean sea level change are summarized by Anny Cazenave and William Llovel in two main points, which are " the addition of fresh water to ocean basins as a result of land ice loss and water exchange with terrestrial reservoirs (soil and underground reservoirs, lakes, snowpack, etc.), and thermal expansion of the sea waters in response to ocean warming" (CAZENAVE; LLOVEL, 2010, p.152). When dealing particularly with the increase of sea level, climate change has misshapen impacts on coastal zones around the world, and as a result, the integrated populations in these regions are faced with the need to migrate to safer areas. Considering the "intrinsic relationship between global warming and the oceans" (MOREIRA; SILVA,2020, p.325), the analysis aims to understand the sea level rise as a consequence of the imbalance in the ecosystem due to climate change and its possible effects on the global community.

Scientists regard the Industrial Revolution as the starting point for human industrial activities, creating a sense of development and modernization (VIOLA; BESSA, 2016). The First Industrial Revolution, around 1760, was a mark for world society development, in which the migration of men to the cities occurred, displacing the agrarian and manufactured labor. A conversion was made by adhering to a more efficient, industrial and mechanized production method, emphasized by the high production of iron from coal (LIMA; OLIVEIRA NETO, 2017). Taking a look at figure 1, it is possible to see how the temperature underwent several variations, until the 1940s, when the temperature began to surpass the average.

Figure 1: Annual mean land temperature above or below average (C°)




Source: BBC NEWS, 2020.

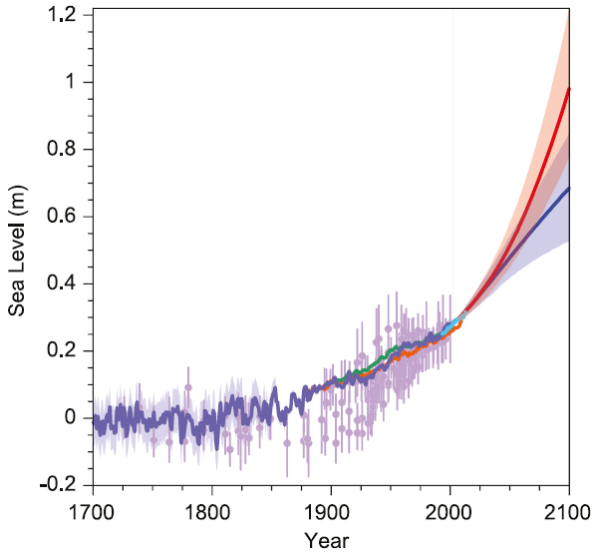
Also, the Industrial Revolution marked the beginning of the Anthropocene era. The Anthropocene is defined by Paul Crutzen e Eugene F. Stoermer as a new geological era, which "emphasize the central role of mankind in geology and ecology" (CRUTZEN; STOERMER, 2000, p.17). The point that this term refers to is that in this new era, the old environmental stability – when there were still balanced greenhouse gas levels – is at stake, due to the consequences of the modern economic, political and social model guaranteed since the Industrial Revolution. In other words, the Anthropocene refers to "the work of humanity, which has become the main vector of changes in the planetary system" (VIOLA; BASSO, 2016, p.1). Speaking of climate change, it is necessary to address this issue not only as an environmental problem,

but also as a social and political one.

Climate change seems to be a distant problem for many people, which is why the matter is often neglected, even though it is a consequence of human actions on the environment. However, the problem has started to grow closer to reality. As an example, climate migration started to point out in different areas of the globe. The World Bank's GroundsWell report (2018, p.14) estimates migration of 143 million people in three main regions by 2050, due to the consequences of climate change (RIGAUD et.al, 2018).

Since the beginning of the 21st century, Earth has never reached high temperatures so fast since 55 million years ago (CUMMING, 2015). Of the various consequences of this increase, the ice's melting in Antarctica and the ocean warming is becoming a concern for coastal areas. In some Pacific Islands, this is already a reality to be faced. The increase in sea level caused the immersion of eight islands in the region. The Federated States in Micronesia, basically formed by the conglomerate of islands, are also threatened by the risk of submersion (PODESTA, 2019). NASA data pointed out that "global sea level has been rising at a rate of 0.1 inches (3.3 millimeters) per year in the past three decades" (NASA, 2020).

Figure 2: Assessment of the likely range of sea level rise for the 21st century




Source: IPCC, AR5 Fig. 13.27.

In figure 2, which appears in the report prepared in 2013 by the Intergovernmental Panel of Climate Change (IPCC), it is possible to see that from the 20th century onwards, sea level rises exponentially, predicting a sixfold increase until the end of the 21st century (CHURCH; WHITE, 2011). For cities, climate change consequences will have large proportions, especially those metropolises surrounded by water, such as New York, Venice, Mumbai and Rio de Janeiro, meaning "significant implications for countries and future development planning" (RIGAUD et. al, 2018). With the exponential increase of greenhouse gas emissions and the worsening of climate change, water floods will not be a sudden fenomen. In reality, floods that used to be inexistent are starting to become casual in the current times. The ice melting has pushed the coast towards the interior, as it is the case of Jakarta, Shanghai, and New Orleans, known as the sinking cities (BROWN; NICHOLLS, 2019).

Considering the amount of greenhouse gases already emitted into the atmosphere, the forecast is that by 2100 some continental areas will be submerged (WATTS; KOMMENDA; HOLDER, 2017). The rising sea level needs special attention from the global community, as it impacts not only the population that inhabits the coastal areas of the globe but the other areas that will have to deal with the reception of possible migrants. Thinking about a warm future leads the community to act towards mitigation and adaptation policies. In the specific case of rising sea levels, mitigation, the prospects appear to be pessimistic. Some cities, such as Shanghai, Osaka and Alexandria, have been developing adaptation methods for rising sea levels, which have been built as preventions for the deterioration of floods, such as incursions, application of drainage methods, and even construction of barriers against flooding (ibid., 2017). Given the scale of the problem, these strategies appear to be only a provisional measure. In this perspective, "[...]it is increasingly clear that for tens of hundreds of millions of people living in low-lying areas and on

small islands, no physical defense is realistically possible or can be fully protective" (BYROVAN, RAJAN, 2010, p. 242).

Therefore, it is more than necessary that the international community, especially the stakeholders States, cooperate in the treatment of this problem and enable the right to migrate to more climatic zones (ibid., 2010). Climate change is a cross-border problem, and individual actions are not effective unless they are aligned collectively, as the consequences will spill over into everyone.

## *References*


BROWN, S.; NICHOLLS, R. J. Sea levels are rising fastest in big cities – here's why. **World Economic Forum**, 23 de março de 2021. Disponível em: https://www.weforum.org/agenda/2021/03/sea-levels-cities-climate-change-ocean/. Acesso em: 16 abr. 2021.

BYRAVAN, S.; RAJAN, S. C. The Ethical Implications of Sea-Level Rise Due to Climate Change. **Ethics & International Affairs**, v. 24, no. 3 (2010), pp. 239–60. Disponível em: https://www.researchgate.net/profile/Sudhir-Rajan/publication/227987827_The_Ethical_Implications_of_Sea-Level_Rise_Due_to_Climate_Change/links/5c147f9da6fdcc494ff521e4/The-Ethical-Implications-of-Sea-Level-Rise-Due-to-Climate-Change.pdf. Acesso em: 16 abr. 2021.

CAZENAVE, A.; LLOVEL, W. Contemporary Sea Level Rise. **Annual Review of Marine Science.** vl. 2:145-173, 2010. DOI: 10.1146/annurev-marine-120308-081105.

CHURCH, J.A; WHITE, N.J. Sea-Level Rise from the Late 19th to the Early 21st Century. **Surveys in Geophysics**, v. 32, pp. 585-602, 2011. DOI 10.1007/s10712-011-9119-1.

CRUTZEN, P.; STOERMER, E. "The Anthropocene". **Global Change Newsletter**, v. 41: 17-18, 2000. Disponível em: http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf. Acesso em: 15 abr. 2021.

CUMMING, V. How hot Earth could get?. **BBC**, 30 de novembro de 2015. Disponível em: http://www.bbc.com/earth/story/20151130-how-hot-could-the-earth-get. Acesso em: 16 abr. 2021.

LIMA, E. C.; OLIVEIRA NETO, C. R. Revolução Industrial: considerações sobre o pioneirismo industrial inglês. **Revista Espaço Acadêmico**, 17(194), 102-113, 2017. Disponível em: https://periodicos.uem.br/ojs/index.php/EspacoAcademico/article/view/32912. Acesso em: 15 abr. 2021.

MOREIRA, F. K.; SILVA, J. C. J. Deslocamentos humanos a partir da elevação do nível do mar. *In:* SILVA, S.; SANTOS, M.; MENEZES, D. (Org.). **Direitos, cidadania e desenvolvimento sustentável.** 1 ed. São Paulo: Eseni Editora, 2020, v. 1, p. 322-339.

NASA. **California's Rising and Sinking Coast.** 01 de novembro de 2020. Disponível em: https://earthobservatory.nasa.gov/images/147439/californias-rising-and-sinking-. Acesso em: 16 abr. 2021.

PODESTA, John. The climate crisis, migration, and refugees. **Brookings**, 25 de

julho de 2019. Disponível em: https://www.brookings.edu/research/the-climate-crisis-migration-and-refugees/. Acesso em: 16 abr. 2021.

RIGAUD, K. et al. **Groundswell: Preparing for Internal Climate Migration**. Washington, DC: The World Bank, 2018. Disponível em: https://www.worldbank.org/en/news/infographic/2018/03/19/groundswell---preparing-for-internal-climate-migration. Acesso em: 06 mai. 2021.

VIOLA, E.; BASSO, L. O Sistema Internacional no Antropoceno. **Revista Brasileira de Ciências Sociais**, São Paulo, v. 31, n. 92, 2016. DOI 10.17666/319201/2016.

WATTS, J.; KOMMENDA, N.; HOLDER, J. The three-degree world: the cities that will be drowned by global warming. **The Guardian**, 2 de novembro de 2017. Disponível em: https://www.theguardian.com/cities/ng-interactive/2017/nov/03/three-degree-world-cities-drowned-global-warming. Acesso em: 16 abr. 2021.

WHAT is climate change? A really simple guide. **BBC NEWS**. 18 de nov. de 2020. Disponível em: https://www.bbc.com/news/science-environment-24021772. Acesso em: 16 abr. 2021.