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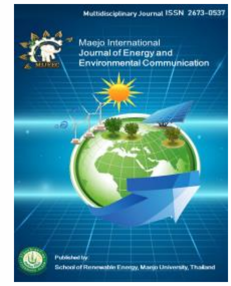

ARTICLE

Climate change: Consequences for neglecting the early warnings a brief testimony

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A B S T R A C T

To a great extent reversing the effects of climate change is almost unfeasible. The impact has grown to a near-final stage. The results certainly cost a lot to human beings. Humans undoubtedly initiated the current deteriorating state through their activities to achieve the so-called 'development'. On the other hand, the deterioration effects have not happened in one day but at a relatively slower pace with numerous indications (rise in temperature, sea level, CO_2, land disappearing, unpredictable sudden weather changes) that have been missed or neglected. The most that can be done now is to reduce the deterioration rate, which is only possible with collective efforts from all nations, especially the top-emitting countries. Simultaneously, people must adapt to the ever-changing climate and its consequences by devoting themselves to early warning systems. This report highlights those early indications (warnings) and the effects by neglecting those warnings and suggesting adaptation by focusing on early climate information.

1. Introduction

Climate change is primarily due to the rise in the global average temperature. Though the shift in weather patterns can happen naturally due to human activities, evolution has accelerated from its moderate pace (UN Climate Action, 2022). The effects of climate change can be felt in every aspect of life, directly or indirectly, regarding food security, unprecedented diseases, social implications, water security, and energy crisis. This review aims to raise awareness of climate change, the indicators, the consequences, and what can be done next to deal with climate change. Although there are many previous articles on climate change, very few focus on the indicators humankind has missed. As such, this review will reinstate the importance of those indicators. Droughts have long been considered an incremental yet long-term and cumulative environmental change, and it is also referred to as a slow-onset or creeping phenomenon (Pulwarty and Sivakumar, 2014). Soil degradation and desertification processes, ecosystem changes and habitat fragmentation, nitrogen overloading, and coastal erosion are all examples of slow-onset but rapid-transition issues. Such gradual alterations are frequently ignored in their early phases. Abandoned creeping alterations can eventually become severe crises that are more expensive to deal with because critical reversibility thresholds have been exceeded (Glantz, 2004). Early warning systems (EWS) are required for event commencement when limits are exceeded and for event acceleration and duration spanning from a season to

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decades and from a few hundred km to hundreds of thousands of km. Coastline floods and degradation are global issues (Zedler and Kercher, 2005). Coastal erosion is a complicated issue with various dependent and dynamic elements fluctuating across time and space (Paprotny et al., 2021a). Waves and tides, currents, winds, and storm surges affect coastal environments' erosion dynamics. This erosion is also exacerbated by an observed decrease in sediment inputs to beaches, which is produced by a reduction in sediment flux to the sea because of, for example, sediment entrapment in dams or riverbank stabilizing works (Cunha et al., 2021).

All these pressures strain marine habitats, compromising their economic worth and the myriad Ecosystem Goods and Services (EGS) they supply (Cabral et al., 2017). These ecosystems provide EGS such as biological habitat, carbon sequestration, and storm and flood protection (Teagle et al., 2017). Coastal habitats, such as salt marshes or vegetated dunes, reduce the severity of waves and storm surges in many coastal regions, reducing coastal areas' vulnerability to flooding (Menéndez et al., 2020). This shielding is obtained via the direct dissipation of surge and wind energy and through their ability to store sediments, which promotes accretion rates and dune formation (Jackson and Nordstrom, 2018).

The present review was followed by several ongoing efforts to examine and improve climate-related impact assessment and information systems for reacting to natural disasters, including flooding and drought. These risks span the weather-to-climate continuum, with drivers operating on timescales ranging from seasonal to decadal and longer. Due to progressive development, humans have unintentionally invited numerous self-destruction forces (Duarte et al., 2013). We believe we still have time to change course by mitigations. On the other hand, data indicate that we are well beyond the mitigation phase, perhaps possible with comfort to a certain extent, and the rest lies with adaptation. Daily waste resources, such as food waste, indicate our shallow consciousness of preserving nature and its resources. Many admit that protecting the earth is a shared responsibility, but when a situation warrants mending any damage, the burden is thrown onto others. This present review attitude was carried out long until we neglected numerous clear warnings. While data on the CO_2 trend covers the duration of 1960-2020, data on sea level includes 1880-2020 and global temperature from 1860 to 2020. All the data were collected from well-established organizations. With several articles discussing climate change, this work aims to consolidate many indicators exhibiting the risk rate from climate change.

2. Apparent climate change indicators

2.1. Atmospheric CO_2 level

One of the very apparent indications is the ever-increasing atmospheric CO_2 level. Being the leading greenhouse gas, CO_2 has affected the globe for centuries. Hence, CO_2 is one of the most crucial climate change-related indicators. Greenhouse gases create a trap so that excess heat cannot escape and radiate back to the atmosphere, aiding global temperature rise. From about 315ppm in 1960, we have recorded around 415ppm (Figure 1) according to data statistics (2022). The steady increase in atmospheric CO_2 level was a clear warning that has been neglected. Figures are alarming if we look at the slope every ten years. From a 0.8 ppm/year gradient in 1960-1970, we have achieved a terrifying rise of 2.4 ppm/year during 2010-2020. If the trend continues, the world will reach the high-risk mark of 450 ppm at the latest by 2047, if not earlier. The inset in Figure. 1 (Rate of CO_2 increase (ppm/year) for every ten years) indicates the ever-increasing rate of CO_2 concentration from the year 1960 to 2020. A continual increase in global atmospheric CO_2 concentration creates a blanket to trap heat from the earth, causing global temperature to rise. With the ever-increasing gradient (Figure. 1, inset), the 450-ppm mark might be achieved earlier than 2047. The increasing CO_2 level, on the other hand, significantly impacts land organisms, ocean acidity, and the survival of its creatures.

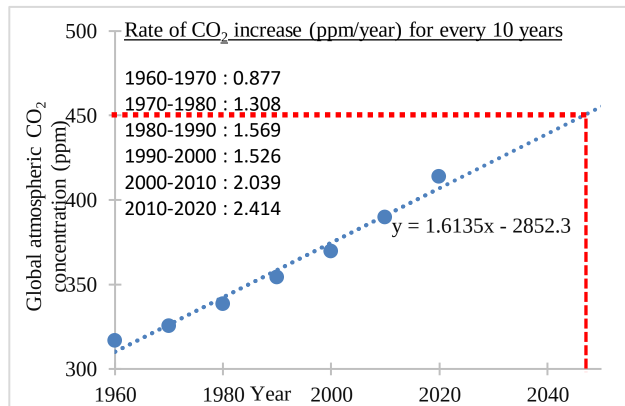

Figure 1. Global atmospheric CO_2 concentration (ppm) from 1960 to 2020 (Statista, 2022)

2.2. Maritime level

It is reported that the sea level has been on a rising trend since 1880, gradual from 1880 to 1960 and a considerable steep increase (Figure. 2). The drastic increase is probably devoted to ice and glacier melting due to warmer global average temperatures resulting from CO_2 rise. It is predicted that 200 million people will go below sea level by 2100 (Kulp and Strauss, 2019). In addition, due to the shrinking of land and saltwater encroachment, agricultural activities are affected and, in the long run, affect the food supply. The Figure shows that the trends of cumulative sea level change recorded by the National Oceanic and Atmospheric Administration (NOAA) and Commonwealth Scientific and Industrial Research Organization (CSIRO) agree to reflect the rise in sea level is a natural phenomenon. The uprising trend that is on the rise, even as per today's data, is a severe warning to carry out countermeasures to protect many coastal cities from losing their land area.

Although little attention is given (compared to the continuous sea level hike), numerous ecosystem disruptions are evident, and the implications are considerable. The scenario has been regarded as one of the utmost potential reasons for ecosystem disorder, placing several coastal areas in danger of unalterable changes (Rullens et al., 2022).

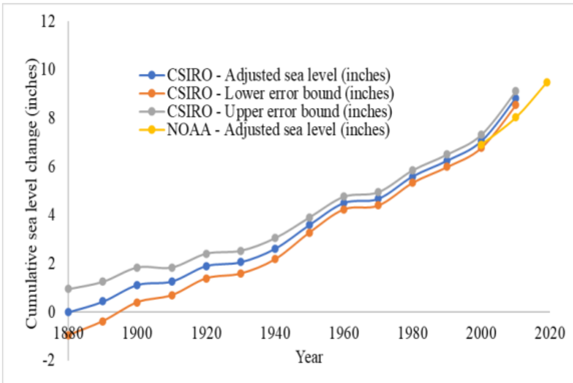

Figure 2. Cumulative sea-level change in inches from 1880 to 2020 monitored by CSIRO and NOAA.

2.3. Planet temperature shift

The earth's temperature has remarkably soared since 1880, sustaining the uphill trend until today (Figure 3). The rate of temperature change is worrying as though there will be no chance it will be a flat curve shortly, let alone the opportunity of a downhill trend.

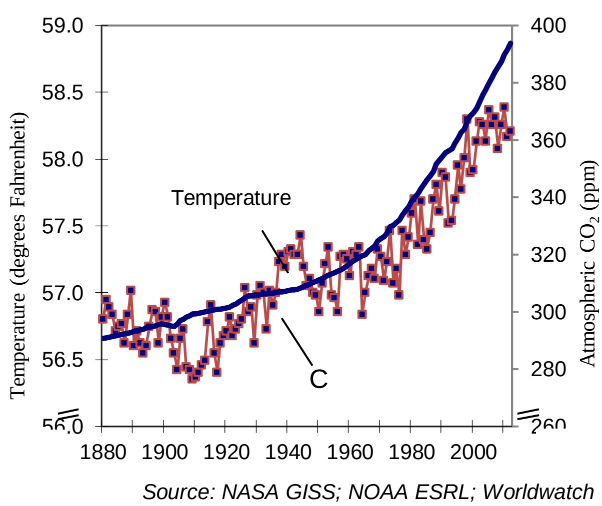

Figure 3. Average global temperature (ºF) and atmospheric CO_2 as recorded by several agencies from 1880 to 2012 (EPI, 2022)

There is a correlation between temperature increase and CO_2 rise. As the global average temperature has risen, the world has seen the perish of many organisms (EPI, 2022). The data on temperature and CO_2 depict that an early warning was alarmed much earlier years, and the warning continues until today, only showing our negligence in taking more meaningful actions to reverse it. The powerful signals have been unattended to, and only lately have serious roundtable discussions been initiated globally.

3. Consequences of neglecting the early warnings

3.1. Land degradation

Land degradation is defined as an adverse drift in land conditions originating from direct or indirect human activities that affect at least one of the following: biological productivity, ecological integrity, or value to humans (IPCC, 2014). The stated aspects (biological productivity, environmental integrity or value to humans) reduction or loss is very much linked to climate change (Climate change and land, 2019). About 70% of the ice-free land area is utilized for our necessities. Surprisingly there was an increase of 1.5 ºC in global mean surface temperature for ten years (2006-2015) as compared to 50 years (1850-1900) that intensified land degradation (Climate change and land, 2019). Subsequently, it exaggerates unpredictable weather patterns and causes sudden floods and droughts. The fertile land area then shrinks and creates desertification. Deserts are formed naturally over a relatively long period, but due to land degradation, deserts can be included in a much shorter period, making land less efficient in absorbing carbon. As for now, a 5.43 million km2 area of drylands has been degraded, affecting over 90% of people in developing economies (Burrell et al., 2020). Desertification is prevalent, and more drylands are at high risk of desertification. Hence, the agricultural yield will be significantly affected, creating socio-economic issues, poverty, food scarcity, and malnutritional.

On the other hand, due to land degradation, efforts to change the under-quality land to intensify, more fertilizers and energy to be used, cost escalating so does the associated pollutions; land and water bodies pollutions; due to under-quality ground, frequent flash floods, heatwaves, and drought that resulted in landslides, lives and livestock loss, loss of biodiversity, and many livelihoods. The report says that the Least Developing Countries (comprised of 46 countries), with 13% of the world population, will be affected the most, as they are the most susceptible group and are economically behind in taking necessary precautions, according to UN (2022).

The rise in average global temperature affects the balance between ice melting and snowfall replacement. While snow is decreasing, more ice stocks get melted, shaking nature's equilibrium that has been maintained for ages (EPA, 2022). EPA Reports say that the reduced snowfalls with shrinking snow cover on land affects the insulating effects for vegetation and wildlife and affects many living states regarding food and water supply, transportation, and recreation (Climate change and land, 2019). The list goes long to include coastal erosion, storms, and loss of properties, although the situation gives credit to ice-free shipping and more access to natural resources. Hot temperature creates high humidity, and the combination of heat and moisture is termed 'wet-bulb temperature', making it more challenging to vaporize sweat and body heat (Mellen and Neff, 2021). This condition demands the usage of a cooling mechanism (through air-conditioning or other means) and ends up with more energy usage and CO_2 release.

3.2. Forest

Forests are at the heart of the 2030 Agenda for Sustainable Development (Rome, 2020). Globally, more than 1 billion people rely on them for food, medicine, and biofuel. They help combat climate change by protecting soils and water, hosting more than three-quarters of the world's terrestrial biodiversity, and protecting soils and water. Nutrient cycling, recreation, and tourism are all examples of social-ecological services (Li et al., 2022). Trees generally contain 50% carbon by volume (Birdsey, 1992). The carbon sequestration process removes carbon dioxide from the atmosphere by the forest, converting it to carbon and storing it in wood and plants.

Furthermore, forests' overall biomass serves as a "carbon sink." According to studies published by the United Nations Food and Agriculture Organization (2020), forests store significant amounts of carbon. The world's forests store over 1 trillion tonnes of carbon, more than double the quantity floating freely in the atmosphere. Activities like deforestation and forest fires release billions of tonnes of carbon into the sky. Effectively, increasing storage and keeping stored carbon from being released into the atmosphere are critical methods for mitigating global warming and environmental conservation. Climate change is inextricably related to forests as a cause and remedy. Climate change has an impact on forest health, distribution, and composition. This situation increases the evidence that forests are under considerable threat (FAO, 2020).

Most deforestation occurs along 24 fronts across Latin America, Sub-Saharan Africa, Southeast Asia, and Oceania. The Amazon, Central Africa, the Mekong, and Indonesia appeared in WWF's prior research in the 2015 Living Forests Report (Pacheco et al., 2021). New fronts have also emerged in West Africa (Liberia, Ghana), East Africa (Madagascar), and Latin America, including the Amazon in Guyana and Venezuela and the Maya Forest in Mexico and Guatemala (Pacheco et al., 2021). Forests currently cover 30.8% of the worldwide land area (FAO-FRA, 2001).

Forests cover 4.06 billion hectares or about 0.5 hectares per person; however, they are not evenly dispersed worldwide. More than half of the world's forests are found in only five countries (Russia, Brazil, Canada, the United States of America, and China), and two-thirds (66%) are found in just ten countries (FAO-FRA, 2020). The University of Maryland and World Resource Institute (2022) reported that the world had 3.92 Gha of tree cover, extending over 30% of its land area. It lost 25.8 Mha of tree cover in 2020. Figure 4 depicts that the rate of net forest loss has decreased significantly, attributed to the awareness of the nations on the importance of the forest and the expansion of forest area. The rate declined from 7.8 million ha/year in 1990-2000 to 5.2 million ha/year in 2000-2010 and 4.7 million ha/year in recent years between 2010-2020 (FAO-FRA, 2020).

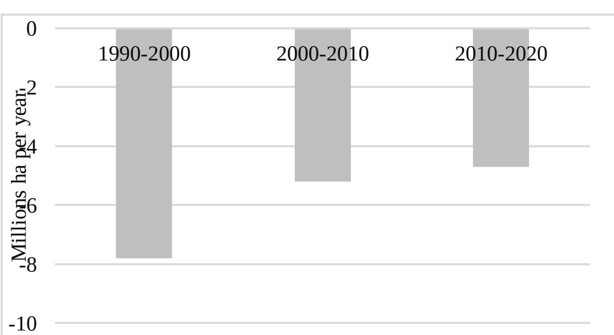

Figure 4. Global annual forest area net change by decade, 1990–2020 (FAO-FRA, 2020).

Bragagnolo (2021). reported that illegal deforestation had become a worrying environmental issue in Brazil, affecting the whole region of the country. The Atlantic Forest has significantly degraded vegetation cover to the point that less than 15% of the original forest remains (Wagner et al., 2020). More than 80% of the remaining Atlantic Forest fragments were less than 50 hectares, while natural reserves only protected 9% of the remaining and 1% of the original forest. According to the annual deforestation report for 2019, the Brazilian territory lost 12,187 km^2 of plant cover (Bragagnolo et al., 2021). Indonesia reported losing 748,640 ha of forest from 2001 to 2019 in industrial plantations, selective natural timber extraction, inland water bodies, roads, and population centers, fire, mining, and other drives (Gaveau et al., 2021).

4. Impact of climate change

Increased population causes deforestation and the expansion of agricultural and urban areas (Jothityangkoon et al., 2013; Muto et al., 2022). Climate change evidence over geological time scales has been known for a long time and is linked to natural causes. Temperatures are rising faster than ever, and precipitation is falling on many planets (Masson-Delmotte et al., 2018). Scientific reports show that record-breaking high temperatures due to extremes of climate, such as floods and droughts, can be unsafe for living things on Earth (FAO and UNEP, 2020; Pacheco et al., 2021), But this becomes the new "regular" weather regime (FAO-FRA, 2001). Deforestation causes a drastic loss of biodiversity globally. The extinction of animal and plant species is a result of habitat loss. Forests consist of 70% of all animal and plant species. Rainforest trees function as shelters for certain animals and regulate canopy temperature. The extreme temperature occurs between day: and night cycles due to deforestation. This situation could be lethal to certain inhabitants (FAO-FRA, 2001).

Humans breathe out CO_2, vehicles and industries emit CO_2, and interestingly, trees have been blessed to breathe in CO_2 to complete the cycle and maintain atmospheric CO_2 at a certain safe level. So, the importance of forests has been well discussed in international forums, and this view REDD+ is one of the crucial platforms for gathering information on the forest. Developing nations implementing REDD+ activities are required to provide their progress on safeguarding their forests (UNFCCC, 2022). In regulating the required forest area worldwide, the CO_2 cycle is expected to be maintained, in turn maintaining the global average temperature. The trees also help regulate the water cycle, which helps control the amount of water in the atmosphere. There is less water in the air to return to the soil in deforested areas (UNFCCC, 2022). As a result, the earth becomes drier, making it impossible to cultivate crops. This might restrict the amount of food accessible to humans and other animals and cause financial losses for many agricultural firms (Marengo, 2020). Besides that, flooding could become more intense and frequent due to extreme weather amplification, bringing significant consequences to aquatic and terrestrial ecosystems, human civilizations, and the economy (Hamlet and Lettenmaier, 2007). Changes in flood features are influenced by antecedent soil moisture conditions, snowmelt timing, snowpack magnitude in snow-dominated regions, and the spatial distribution, time evolution, and rarity of precipitation (Sharma et al., 2018; Tabari, 2020). Trees aid in retaining water and topsoil and provide rich nutrients to support new forest life. The land erodes and washes away without wood, forcing farmers to move on and continue the cycle. The barren ground left behind due to these unsustainable agricultural techniques is more vulnerable to flooding, particularly in coastal areas. Poor households with limited liquidity and access to credit and insurance are unlikely to smooth consumption. Productivity decreases will reduce their resilience to climate change, potentially leading to poverty traps (Barrett et al., 2009; Masuda et al., 2021).

In addition, warming impacts the most vulnerable people in society and the productivity of personnel well-being. Heat may harm outdoor workers because their principal livelihood strategies, such as farming, require them to engage in strenuous physical activity for long periods (Masuda et al., 2021). Rural communities in low-latitude and low-income nations are projected to suffer from climate change and deforestation [40]. Deforestation-induced warming could enhance vulnerability to climatic and other shocks, as many tropical countries often exceed human safety thresholds (Mora et al., 2017).

Carrillo-Niquete (2022) reported that increasing heat in the environment affects the ozone generation in the lower atmosphere, increases the consumption of households and electricity increases in tropical cities, and influences the socioeconomic disparity in the territory and environmental quality. Deforestation has produced indirect economic loss due to many initiatives blocking the import of Brazilian products from operations suspected of contributing to illegal deforestation (Arruda et al., 2021; Bragagnolo et al., 2021). Ancient civilizations and indigenous populations still use rainforests as a habitat. It gives aesthetic or spiritual cultural value as well as places of sanctuary. If forests are lost, so are the values that disappear too. This leads to migrations among tribes worldwide. In addition, the rural population's quality of life is deteriorating as they are exposed to harsher weather and must walk greater distances to get firewood or hunt animals. Other food sources become increasingly inaccessible as the (rain) forest deteriorates. Hunger and emigration are the results, especially among the poor community (Rude et al., 2021). Global climate phenomena like the El Nio-Southern Oscillation cause droughts in Amazonian rivers. Water stress and wildfires may increase the mortality of trees in the Amazon due to hotter and drier circumstances. Increased tree mortality could hasten the demise of floodplain forests, which have already been cut by 70% for agricultural and cow ranching uses. Immediate action is needed based on research and practicality for understanding the implications of climate change on the global, particularly the effects of deforestation, drought, and fire on humans, animals, and ecosystems. If the climate continues to warm, the probability of severe floods, fires, and deficiencies is projected to rise, and precautions must be taken to mitigate their effects.

4.1 The disappearance of low laying islands

The continuous degradation of permafrost and frozen ground is the leading cause of the increase in water discharge in the northern hemisphere due to the climatic change and several morphological changes at the end of the 20th century, creating new islands and more extraordinary, eroded surfaces accelerated migration of islands (Gautier et al., 2021). The hydrological changes are highlighted in Arctic rivers dominated by the increase in water flow at the beginning of the 21st century (Peterson et al., 2002). Climate change and accompanying sea-level rise have increased the risk in the future due to chronic and acute pressures within the communities and ecosystems (Hinkel et al., 2018; Pollard et al., 2022). Sea level rise rate, sediment starvation, and undulating seafloor topographies can cause barriers to the founder or drowning (Emery et al., 2019), and the shoreface translates to a new landward position in a process described as 'overstepping' (Pollard et al., 2022).

4.2 Submergence and increased flooding of coastal lands

In the 21st century, Sea level rise is one of the significant consequences of global warming, one of the most everyday phenomena in the coastal areas; due to their geographical location, they will be exposed to extreme weather events, such as flooding (Amoura and Damani, 2022). This phenomenon affects most coastal cities threatened with submergence (Aouissi, 2019). Seawater temperature increases due to rising sea levels, and among the coastal risks, marine submersion is a recurrent concern of the states (Amoura and Dahmani, 2022; Timmerman et al., 2021; Kuhn et al., 2011). High-tide floods are already a familiar problem in many cities worldwide; more than 600 such floods occurred in 2019. From the mid-2030s, however, the alignment of rising sea levels with a lunar cycle will cause a decade of dramatic increases in flood numbers, considering all known oceanic and astronomical causes for floods (NOAA, 2021).

4.3 Increase erosion and habitat destruction in coastal areas

Increasing sea level rise, the frequency and intensity of storms, and degrading ecosystems expose coastal areas to higher risks of damage by storm events. The anthropogenic activities in coastal areas, such as living, leisure and economic activities, are under high pressure on the coastal ecosystems, which are more threatened due to sea level rise (Barbier et al., 2011). The sea level projected to increase by 0.62–1.11 m will introduce additional pressure to the coastal regions and increase their biophysical alterations and erosion potential, increasing their vulnerability (IPCC, 2014; Cunha et al., 2021). Coastal erosion is complex, with many underlying and dynamic factors that vary at temporal and spatial scales. Factors like waves and tides, currents, winds, or storm surges have an active role in the erosion dynamics of coastal regions (Vousdoukas et al., 2020; Paprotny et al., 2021b). The soil erosion is also exacerbated by reducing sediment inputs to the beaches, caused by the reduced sediment flux to the sea (Cunha et al., 2021).

4.4 Saltwater inclusion of surface and subsurface waters

Increasing the sea level leads to a severe threat to the coastal zones, permanent submergence of land with high tides, more frequent or intense coastal flooding, enhanced coastal erosion, changing the structure of the ecosystems, salinization of soils, ground, and surface water with the impeded drainage. The rising sea level affects the groundwater or surface water quality, becoming a severe threat of saltwater intrusion, changing water demands, and drought. Rising sea levels, lack, and changes in water demand and availability can add salinity to groundwater and surface water sources of drinking water (EPA, 2020). Increasing the groundwater pumping can also increase the saltwater intrusion into groundwater, increasing the cost of the drinking water facilities and the unusable groundwater wells. So, the saltwater intrusion might diminish the groundwater quality availability for drinking. Groundwater heads at and near the coast will increase in parallel rather than remaining at their current position (Safi et al., 2011; Valett and Reinhold, 2022). However, the increase in the groundwater table near the sea boundary will not be associated with a similar rise in groundwater levels at the landside (Sherif and Singh, 1999; Le et al., 2021). Coastal aquifer hydrodynamics and climate change impacts remain challenging to quantify and predict coastal communities' economic, social, and environmental security.

5. Monitoring systems

5.1 Seawater intrusion

Seawater intrusion has been here for many centuries. Efforts have been made as early as the 1880s to manage this seawater invasion, as it dramatically affects the water sources for drinking and agricultural activities. A reliable seawater intrusion monitoring system is a must in this era as an early signal of one of the climate change indicators. Of many methods to measure the intrusion, conventional methods are groundwater level measurement, hydrograph analysis, water compositional analysis, and well logging (borehole logging) (https://ca.water.usgs.gov/sustainable-groundwater-management/seawater-intrusion-california.html.
Data derived from these methods provide a seawater encroachment profile with high reliability. In addition, borehole electromagnetic logs that associate the conductance with salinity; and airborne electromagnetic monitoring to chart electrical sensitivity that eventually correlates to seawater encroachment are among the recent reliable monitoring methods. One such monitoring is by the United States Geological Survey in Florida via a saltwater intrusion monitoring network to prevent and even reverse the seawater intrusion from contaminating their groundwater (https://www.usgs.gov/mission-areas/water-resources/science/saltwater-intrusion).

5.2 Flood

Economic losses caused by floods were estimated at around 90 billion US dollars in 2021 (Alves, 2021). An early warning system for floods is designed to identify potential flooding situations in advance and issue timely alerts to the concerned authorities and people living in the affected areas. There are some critical components of an effective early warning system for floods. Monitoring and forecasting are the first steps to monitoring weather conditions and water levels in rivers and other water bodies (Vousdoukas et al., 2020). Global flood monitoring was integrated into GloFAS to allow the continuous flood monitoring of floods worldwide by immediately processing and analyzing all incoming Copernicus Sentinel-1 Synthetic Aperture Radar. Gauge-adjusted radar rainfall uses two independent sensors that each indirectly measure rainfall. It provides better maps of rain than either sensor could produce alone. Sung et al. (2022) reported that water level and velocity could determine the potential of flooding on mountain slopes by using the LoRa plus a global system for mobile communications mode to carry out efficient and convenient data transmission. Besides that, utilizing artificial intelligence helps interpret data and utilize data for prediction and forecasting floods more accurately. This consists of hydraulic models optimized for tensor processing units (Perera et al., 2020).

6. Concluding remarks

The hope that the trees for photosynthesis can discount the excess CO_2 emission is irrelevant due to forest shrinking. More CO_2 and lesser forest areas absorbing excess CO_2 are two compounding effects of environmental destruction. The ocean is best at storing heat; the ocean absorbs excess heat from the atmosphere. How many years can the ocean absorb the heat generated on land without transferring the resultant adverse effects to its inhabitants? In addition, the false and misleading claims on greenwashing further intensify the destruction. Perhaps greenwashing is not new, but it has been amplified lately in line with the growing awareness among people of green and sustainable developments. Integrated outcomes of all these scenarios sensibly lead to early destruction earlier than predicted. In addition, the less prosperous countries in total quantum do not reach wealthy nations' funding pledges. The next course of action is probably the adaptation to acclimatize to the changing environment. Directing funds to early warning systems is crucial then. Several precautions are necessary for the transformation, which include (but are not limited to) sea walls, coastal protection systems, desalination for water security, wastewater treatment for reuse, seeds conservation (seed bank), infrastructure that can withstand tremor and flood, building insulation, afforestation to deal with excess CO_2, carbon monitoring system and so on (IPCC, 2014). Behavior shifts and climate change knowledge (through formal education) are among the vitals to be adopted by the present-day generation. One obvious thing is that we are still not passing the awareness point, evident from the food wastage where we buy more than we need- greed. The list goes on, and so does the production of CO_2 and global temperature. Monitoring systems may give awareness of climate change.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

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References

Alves, B. (2023). Global flood economic losses 2021, by type. https://www.statista.com/statistics/1326526/economic-losses-floods-worldwide-by-type/#:~:text=Global%20flood%20economic%20losses%202021%2C%20by%20type&text=In%202021%2C%20economic%20losses%20caused,total%2C%20at%2020%20billion%20dollars.

Amoura, R., & Dahmani, K., (2022), Visualization of the spatial extent of flooding expected in the coastal area of Algiers due to sea level rise. Horizon 2030/2100, Ocean Coastal Management, 219, 106041.

Aouissi, K.B., (2019). Alger; Prospection D'une Reconversion Portuaire Compar´ee. thesis, 1. Ferhat Abbas university Setif, p. 283.

Arruda, D., Candido, H. G., & Fonseca, R. (2019), Amazon fires threaten Brazil's agribusiness, Science, 365(6460), 1387-1387.

Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., & Silliman, B. R., (2011), The value of estuarine and coastal ecosystem services. Ecology monographs, 81(2), 169-193.

Barrett, C.B., Carter, M., Chavas, J.-P. Carter, M.R. (2019). The Economics of Poverty Traps (University of Chicago Press, 2019).

Birdsey, R.A. (1992). Carbon storage and accumulation in United States forest ecosystems, US Department of Agriculture, Forest Service, Washington Office, 51p.

Bragagnolo, L., da Silva, R.V., & Grzybowski, J.M.V. (2021), Towards the automatic monitoring of deforestation in Brazilian rainforest. Ecological informatics, 66, 101454.

Burrell, A.L., Evans, J.P. & De Kauwe, M.G. (2020), Anthropogenic climate change has driven over 5 million km^2 of drylands towards desertification, Nature communications, 11, 3853.

Cabral, P., Augusto, G., Akande, A., Costa, A., Amade, N., & Niquisse, S. (2017). Assessing Mozambique's exposure to coastal climate hazards and erosion. International Journal of Disaster Risk Reduction, 23, 45–52.

Carrillo-Niquete, G. A., Andrade, J. L., Valdez-Lazalde, J. R., Reyes-García, C., & Hernández-Stefanoni, J. L. (2022) Characterizing spatial and temporal deforestation and its effects on surface urban heat islands in a tropical city using Landsat time series, Landscape and Urban Planning, 217, 104280.

Climate Change (2014), Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Climate change and land, 2019. https://royalsociety.org/-/media/policy/projects/climate-change/IPCC-special-report-briefing-climate-change-and-land.pdf

Cunha J, Cardona, F.S., Bio, A., & Ramos, S. (2021), Importance of Protection Service Against Erosion and Storm Events Provided by Coastal Ecosystems Under Climate Change Scenarios, Frontiers in Marine Science, 8:726145. doi: 10.3389/fmars.2021.726145

Duarte, C. M., Losada, I. J., Hendriks, I. E., Mazarrasa, I., and Marb,à, N. (2013). The role of coastal plant communities for climate change mitigation and adaptation, Nature Climate Change, 3, 961–968.

Emery, A.R., Hodgson, D.M., Barlow, N.L.M., Carrivick, J.L., Cotterill, C.J., Mellett, C.L., & Booth, A.D. (2019). Topographic and hydrodynamic controls on barrier retreat and preservation: an example from Dogger Bank, North Sea Marine Geology, 416.

EPA, (2020), https://www.epa.gov/arc-x/climate-adaptation-and-saltwater-intrusion

EPA. (2022). https://www.epa.gov/climate-indicators/snow-ice EPI, Energy Policy Institute, 2022.

FAO and UNEP. (2020), The State of the World's Forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en

FAO-FRA. (2001), Global Forest Resources Assessment 2020: Main Report.

Gautier, E., Dépret, T., Cavero, J. Costard, F., Virmoux, C., Fedorov, A., Konstantinov, P., Jammet, M., Brunstein, D. (2021), Fifty-year dynamics of the Lena River islands (Russia): Spatio-temporal pattern of large periglacial anabranching river and influence of climate change, Science of The Total Environment, 783,147020.

Gaveau, D.L., Santos, L., Locatelli, B., Salim, M.A., Husnayaen, H., Meijaard, E., & Sheil, D. (202),. Forest loss in Indonesian New Guinea (2001–2019): Trends, drivers and outlook, Biological Conservation, 261, 109225.

Glantz, M., (2004). Early Warning Systems: Do′s and Don′ts. Workshop Report, 20–23 October 2003, Shanghai, China. 〈www.esig.ucar.edu/warning〉

Hamlet, A.F., Lettenmaier, D.P. 2007. Effects of 20th-century warming and climate variability on flood risk in the western US, Water Resources Research, 43(6).

Hinkel, J., Aerts, J.C. Brown, J.H., Jim´enez, S., Lincke, J.A., Nicholls, D., Scussolini, R.J., Sanchez-Arcilla, P., Vafeidis, A., Addo, K.A., (2018). The ability of societies to adapt to twenty-first-century sea-level rise, Nature Climate Change, 8, 570-578. http://www.earth-policy.org/indicators/c51/temperature_2014.

IPCC, (2014), Summary for policymakers. In: Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, & L.L.White (eds.).

Climate Change (2014), Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1-32.

Jackson, N. L., & Nordstrom, K. F. (2018). Aeolian sediment transport on a recovering storm-eroded foredune with sand fences. Earth Surface Processes and Landforms, 43, 1310–1320. doi: 10.1002/esp.4315

Jothityangkoon, C., Hirunteeyakul, C., Boonrawd, K., Sivapalan, M. (2013). Assessing the act of climate and land use changes on extreme floods in a large tropical catchment. Journal of Hydrology, 490, 88-105.

Kuhn, M., Tuladhar, D., Corner, R., (2011). Visualizing the spatial extent of predicted coastal zone inundation due to sea level rise in south-west Western Australia, Ocean & Coastal Management, 54, 796–806.

Kulp, S.A. Strauss, B.H., 2019. New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding, Nature Communications https://doi.org/10.1038/s41467-019-12808-z

Le, S-T., Gao, Y., Kibbey, T.C.G., Glamore, W.C.&, O'Carroll. DM (2021). Predicting the impact of salt mixtures on the air-water interfacial behavior of PFAS, Science of The Total Environment, 151987.

Li, Y., Liu, Y., Bohrer, G., Cai, Y., Wilson, A., Hu, T., & Zhao, K. (2022). Impacts of forest loss on local climate across the conterminous United States: Evidence from satellite time-series observations, Science of The Total Environment, 02, 149651.

Marengo, J. A. (2020). Drought, floods, climate change, and forest loss in the amazon region: a present and future danger? Frontiers for Young Minds, 7, 8-147.

Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P. R., & Waterfield, T. (2018). Global warming of 1.5 C. An IPCC Special Report on the impacts of global warming of, 1(5).

Masuda, Y.J., Garg, T., Anggraeni, I., Ebi, K., Krenz, J., Game, E.T., & Spector, J.T. (2021). Warming from tropical deforestation reduces worker productivity in rural communities. Nature Communications, 12(1), 1-8.

Mellen, R., & Neff, W. (2021). Humidity and heat extremes are on the verge of exceeding limits of human survivability, study finds. The Washington Post. https://www.washingtonpost.com/world/interactive/2021/climate-change-humidity/

Menéndez, P., Losada, I. J., Torres-Ortega, S., Narayan, S., and Beck, M. W. (2020). The global flood protection benefits of mangroves. Scientific Reports, 10, 1–11.

Mora, C., Dousset, B., Caldwell, I. R., Powell, F. E., Geronimo, R. C., Bielecki, C. R., & Trauernicht, C. (2017). Global risk of deadly heat. Nature Climate Change, 7(7), 501-506.

Muto, Y., Noda, K., Maruya, Y., Chibana, T., & Watanabe, S. (2022). Impact of climate and land-use changes on the water and sediment dynamics of the Tokoro River Basin, Japan. Environmental Advances, 7, 100153.

National Oceanic and Atmospheric Administration (NOAA) (2021), https://www.noaa.gov/

Pacheco, P., Mo, K., Dudley, N., Shapiro, A., Aguilar-Amuchastegui, N., Ling, P. Y., Marx, A. (2021). Deforestation fronts: Drivers and responses in a changing world. WWF, Gland, Switzerland.

Paprotny, D., Kreibich, H., Morales-Nápoles, O., Wagenaar, D., Castellarin, A., Carisi, F., Bertin, X., Merz, B., Schröter, K. (2021a). A probabilistic approach to estimating residential losses from different flood types, Natural Hazards. 105, 2569–2601

Paprotny, D., Terefenko, P., Giza, A., Czapliński, P., & Vousdoukas, M. I. (2021b). Future losses of ecosystem services due to coastal erosion in Europe, Science of The Total Environment, 760:144310.

Perera, D., Seidou, O., Agnihotri, J., Mehmood, H., & Rasmy, M. (2020). Challenges and technical advances in flood early warning systems (FEWSs). Flood impact mitigation and resilience enhancement.

Peterson, B.J. Peterson, R.M. Holmes, J.W. Mcclelland, C.J. Vo, R.B. Lammers, A.I. Shiklomanov, I.A. Shiklomanov, S. & Rahmstorf, (2002). Increasing river discharge to the Arctic Ocean Science, 298 (5601), 2171-2173

Pollard, J.A., Christie, E.K., Spencer, T., & Brooks. S. M (2022). Gravel barrier resilience to future sea level rise and storms, Marine Geology, 444, 106709

Pulwarty, R. S., & Sivakumar, M. V. (2014). Information systems in a changing climate: Early warnings and drought risk management. Weather and Climate Extremes, 3, 14-21.

Rome, I. (2020). Food and Agriculture Organization of the United Nations. Durham, USA: Duke University.

Rude, B., Niederhöfer, B., & Ferrara, F. (2021). Deforestation and migration. In CESifo Forum, München: ifo Institut-Leibniz-Institut für Wirtschaftsforschung an der Universität München.22, (01), 49-57.

Rullens, V., Mangan, S., Stephenson, F., Clark, D.E., Bulmer, R.H., Berthelsen, A., Crawshaw, J., Gladstone-Gallagher, R.V., Thomas, S., Ellis J.I., & Pilditch, C.A., (2022). Understanding the consequences of sea level rise: the ecological implications of losing intertidal habitat, New Zealand Journal of Marine and Freshwater Research, 56:3, 353-370,

Safi, A., El-fadel, M., Doummar, J., Abou Najm, M., & Alameddine, I. (2011). Synergy of climate change and local pressures on saltwater intrusion in coastal urban areas: effective adaptation for policy planning, water international, 43(2)145-164.

Sharma, A., Wasko, C., & Lettenmaier, D. P. (2018). If precipitation extremes are increasing, why aren't floods? Water Resources Research, 54(11), 8545-8551.

Sherif, M.M., & Singh, V.P. (1999). Effect of climate change on sea water intrusion in coastal aquifers, Hydrological Processes, 13(8), 1277 – 1287.

Statista,2022.https://www.statista.com/statistics/1091926/atmospheric-concentration-of-co2-historic/

Sung, W. T., Devi, I. V., & Hsiao, S. J. (2022). Early warning of impending flash flood based on AIoT. EURASIP Journal on Wireless Communications and Networking, 2022(1), 15.

Tabari, H. (2020). Climate change impact on flood and extreme precipitation increases with water availability. Scientific Reports, 10(1), 1-10.

Teagle, H., Hawkins, S. J., Moore, P. J., & Smale, D. A. (2017) stall marine ecosystems, Journal of Experimental Marine Biology and Ecology, 492, 81–98.

Timmerman, A., Haasnoot, M., Middelkoop, H., Bouma, T., & McEvoy, S., (2021). Ecological consequences of sea level rise and flood protection strategies in shallow coastal systems: a quick-scan barcoding approach. Ocean Coastal Management, 210, 105674.

UN Climate Action, (2022).

https://www.un.org/en/climatechange/why-2022-will-matter-climate-action-0

United Nations Framework Convention on Climate Change (UNFCCC). (2022). https://redd.unfccc.int/info-hub.html.

University of Maryland and World Resources Institute. 2022. "Global Primary Forest Loss". Accessed through Global Forest Watch on 08/02/2022 from www.globalforestwatch.org.

Valett, H.M., & Reinhold, A.M. (2022). Groundwater and Surface Water Interaction, Reference Module in Earth Systems and Environmental Sciences, https://doi.org/10.1016/B978-0-12-819166-8.00146-8

Vousdoukas, M.I., Mentaschi, L., Hinkel, J., Ward, P.J., Mongelli, I., Ciscar, J-C., & Feyen, L. (2020). Economic motivation for raising coastal flood defenses in Europe. Nature Communications, 11, 2119

Wagner, F.H., Sanchez, A., Aidar, M.P., Rochelle, A.L., Tarabalka, Y., Fonseca, M.G., & Aragao, L.E. (2020). Mapping Atlantic rainforest degradation and regeneration history with indicator species using convolutional network. PloS one, 15(2), e0229448.

Zedler, J. B., & Kercher, S. (2005). WETLAND RESOURCES: Status, Trends, Ecosystem Services, and Restorability. Annual Review of Environment and Resources, 30, 39–74.