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Beyond the Rising Tide: Towards Effective Climate Policy in Coastal Urban Centers

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Abstract: As urban areas expand rapidly, understanding the complex interactions between human migration, climate change impacts, and biodiversity loss is crucial for effective climate policy. However, comprehensive knowledge of the simultaneous interaction of these aspects is still scarce. Thus, this paper proposes the classification of 'Climate Emergency Coastal Cities', with the categorization of 43 cities into four levels according to their vulnerability (extreme, very high, high, and critical). Our study contributes to evidence-based climate policy and supports efficient resource allocation and interventions for the most vulnerable coastal cities. Highly anthropogenic megacities were ranked as the most sensitive to climate emergencies (Lagos, Nigeria; Jakarta, Indonesia; Los Angeles and Houston, USA; and Hong Kong and Shenzhen, China). It is noteworthy that in countries from both the Global North and South, the entry of new populations is a critical issue, and represents a threat to urban structures and biodiversity; however, in territories with fragile economies and numerous governance challenges, the required structure is still more challenging. The study concludes that integrated urban planning policies are crucial, considering various perspectives and coordinated actions. Policies should address marginalized urban groups and include migrants, and promote human well-being, ecosystem recovery, and climate mitigation, for effective adaptation.

Keywords: climate change; climate emergency coastal cities; ecosystem services; sea level increase; urbanization

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1. Introduction

In recent decades, urban areas have grown at a faster rate than their respective populations [1], with a projection of a 62% increase in the world's population sheltered in cities by 2035 as a result of both natural population growth and migration flows [2]. Accelerated and unplanned urban expansion has social implications, especially for human well-being and health, and also threatens biodiversity and the provision of ecosystem services [3–5]. This scenario has been aggravated by global climate change (GCC), which brings even greater challenges to biodiversity and urban adaptations, with more severity in large and megacities, especially those agglomerations located in coastal areas [3,6]. Seaside cities and settlements suffer from rapid urbanization processes [7] and are on the frontline of climate change. In many cases, they are already directly exposed to the interaction of climatic and non-climatic coastal hazards and will face severe disruptions by 2100 [8–10]. The most socioeconomically fragile populations and those who depend directly on ecosystems are the most vulnerable to GCC [6,11].

Climate disturbances constitute one of the aspects that directly affect human mobility, which is multicausal since the decision to migrate is defined by a combination of different factors [12]. With the planet's urban areas concentrating more than half of the global population in almost 3% of its territory and with 40% of the world's population living in coastal areas, risks associated with climate change to cities, settlements, and key infrastructure will increase rapidly in the medium to long term. These events are expected to affect about one billion people who live in coastal cities [6].

We identify gaps in understanding the impacts of climate change on coastal cities related to the simultaneous combination of factors such as human migration, climate change, and biodiversity loss. As a result, these three dimensions challenge the effective allocation of resources. The paper focuses on contemporary and projected migration patterns, as well as non-linear population movements due to climate change later in the century. Additionally, a lack of research on urban ecology in coastal systems and the interplay between climate change, biodiversity, and ecosystem services [13,14]. To address these issues, the paper aims to introduce the concept of "Climate Emergency Coastal Cities", categorizing these cities into four levels based on their susceptibility to climate change, biodiversity loss, and migration. This classification aims to facilitate decision-making, public policy planning, and climate finance by identifying the most vulnerable cities and prioritizing efforts accordingly.

Studies that have considered exposure to climate risks have been identified in different parts of the world, such as Lagos, Nigeria [15], and Guangzhou and Shenzhen, China [15–17], beyond coastal cities in Europe [18,19], Mexico [20], India [21], and the United States of America [22].

Some works highlight indices for coastal cities, such as the flood vulnerability index [23] and the climate and ocean risk vulnerability index [10], applied in a restricted way for small and medium cities in pilot projects. However, our research has revealed an often-overlooked facet within the literature, namely that coastal large and megacities located both in the Northern and Southern hemispheres face parallel environmental issues arising from climate change. This finding underscores the universality of climate-related threats faced by urban coastal communities worldwide, urging collaborative efforts in mitigating and adapting to these shared challenges. We did not find any reports of a comprehensive classification that covers large and mega coastal cities, and that includes fundamental dimensions for territorial planning in a context of climate change, such as biodiversity and migratory flows; nor did we identify analyses on these dimensions from the perspective of both the Global North and South, since socioeconomic and political criteria can contribute to identifying agglomerations in a situation of greater criticality [7].

Similarly, there is an important knowledge gap on contemporary and projected migration inflows and outflows in coastal cities, as well as on the trend of non-linear population movements at a global scale later this century due to climate change [24]. Although knowledge of the relationship between biodiversity and urban vulnerability has evolved substantially [25,26], important research gaps have also been identified on urban ecology in coastal systems [13] and on climate change, biodiversity, and ecosystem services [27,28]. This evidence suggests the need for research on how the loss of biodiversity and ecosystem services affect the capacity to cope with climate change and other adverse events, especially with a view to targeting adaptive solutions for coastal large and megacities.

The concept of Climate Emergency Coastal Cities reflects the critical and urgent situation faced by large coastal cities due to the impact of climate change, particularly related to sea level rise, with attention to the socio-environmental implications arising from high population concentration, location in biodiversity hotspots, status as migration destinations, and conflicts between urban growth and biodiversity.

Sea level rise in a more optimistic temperature rise scenario triggers a series of significant consequences in these urban areas, which need to be addressed in an integrated manner and considering all their complexity. As climate change interacts with global trends related to the unsustainable use of natural resources, the lack of basic infrastructure, and compromised biodiversity, identifying the areas of greatest vulnerability on a global scale constitutes an urgent action, with a view to prioritizing efforts and resources for coastal integration, as well as the management of areas on a multidimensional and increasing urbanization basis. Such actions must occur based on specialized municipal plans that provide practical conditions for transformation [29]. As climate change impacts increase, resilience planning in coastal cities must consider integrated systems thinking [10,30].

Despite recognizing the complexity of managing interactions between population, infrastructure, and institutions in the face of climate change, existing literature often adopts narrow, sectoral approaches at local or regional scales, overlooking broader systemic relationships [31]. The integration of climate adaptation measures into regular building practices remains insufficient, highlighting the critical need for more comprehensive assessments and actions [32].

The study emphasizes the associations between biodiversity, climate migration, urbanization, displacement to large urban agglomerations, and GCC impacts on physical infrastructure and human settlements in coastal areas. To address these issues, the concept of "Climate Emergency Coastal Cities" is introduced, defining urban agglomerations with over 5 million inhabitants in vulnerable coastal regions.

Urbanization on the coast has led to unprecedented land use changes, exacerbating natural hazard consequences and creating differentiated vulnerabilities. Sea-related hazards, both catastrophic and long-term, threaten coastal cities, compounding existing adaptation and development challenges [6,33].

Incompatibilities between adaptation needs and physical development patterns are common, particularly in poor and marginalized communities, exacerbating existing inequalities [9,34]. Vulnerability is heightened in developing countries due to limited resources, inadequate infrastructure, and weak governance systems [35].

Categorizing cities into different climate risk classes can create political mechanisms and direct resources to territories that may require urgent and comprehensive measures to address issues such as forced migration and biodiversity loss, as well as contributing to the allocation of resources in a more sustainable, efficient, fair, and equitable manner [36,37], since more vulnerable cities may need more investment in climate change adaptation and mitigation infrastructure [35,38]. Furthermore, the categorization and establishment of Climate Emergency Coastal Cities can encourage proactive actions to prevent and mitigate vulnerability, such as the implementation of nature-based solutions, interventions for the conservation and restoration of urban biodiversity, measures to reduce greenhouse gas emissions, green area planning, and natural disaster risk management [39].

2. Materials and Methods

The study area consists of a selection of the world's large and megacities, which are defined as urban concentrations with populations between 5 and 10 million and above 10 million, respectively, and include meta-cities with populations above 30 million.

To establish a classification of large urban agglomerations affected by sea level rise, according to their socio-environmental vulnerability, the following factors were considered: exposure to sea level rise; location in a biodiversity hotspot; status as a migration destination; and conflicts between urban growth and biodiversity. The methodology employed involved a combination of data sources and analyses.

A literature review was conducted on migration, urbanization, and climate change as drivers of change in biodiversity in the context of large and megacities, with demographic characterization of urban settlements with more than five million inhabitants.

For the construction of the theoretical framework, searches were carried out and records were compiled from the Web of Science database, with the selection of documents corresponding to 'article' and 'review', published in any period. The following key descriptors were used: climate change; coastal cities; impact; world population projection; megacities; large urban agglomerations; urban expansion; peri-urban; conflict zones; urban biodiversity; hotspot cities; unplanned; land use change; land use planning; ecosystem services; international migrations; internal displacement; migratory flows; and people. The descriptors were combined to identify the most relevant sources, selected based on the 'Analyze Results' and 'Citation Report' tools. The retrieved records were analyzed and those of greater convergence and relevance to the study were selected. The selected records were then categorized in relation to the themes and sub-themes, according to the research objectives.

An analysis of documents produced by the UN system was also carried out for the themes of migration, biodiversity and ecosystem services, urbanization, climate change, and global demography. This data source was chosen because of the credibility of the information produced, its comprehensiveness, standardization, and international recognition of its publications. Although the population estimates used have uncertainties due to various factors that may affect the evolution of the world population, the data were generated by the UN, the main organization that produces regularly updated estimates and forecasts of the population and other topics covered by our study, whose information is used throughout the system, including for monitoring global development policies [2,3,6,9,11,40–42].

Based on previous insights presented at the 2nd International Conference on Water, Megacities and Global Change [4], we then used the Resource Watch online platform [40] to simulate sea level rise due to climate change and to identify the large urban agglomerations that are expected to be affected. The platform was selected because it provides access to a wide range of geospatial data and information related to environmental, social, and economic issues, from the aggregation of datasets from various authoritative sources (government agencies, research institutions, and international organizations) with the aim of providing a deeper and more informed understanding of the challenges related to global sustainability [40].

Preliminarily, we checked the likely global average sea level rise relative to the period 1995–2014 for the five possible Shared Socioeconomic Pathways (SSPs). The SSPs are baseline narrative scenarios that identify assumptions of socio-economic, geopolitical, economic, and technological trends, combined with Representative Concentration Pathway (RCP) scenarios. The SSP-RCP scenarios impose global warming targets on the baseline SSP scenarios using the radiative forcing levels of the RCP scenarios, for very low emissions (SSP1-1.9), low emissions (SSP1-2.6), intermediate scenario (SSP2-4.5), and very high emissions (SSP5-8.5) [41].

The Resource Watch portal was employed to visualize projections of sea level rise under a range of scenarios, with the SSPs providing the baseline data for greenhouse gas emissions patterns that influence these projections. These emissions scenarios have been integrated into the portal's simulation tools, which allow us to observe the impact of different socio-economic trajectories (SSPs) on sea level rise.

Using the simulation tools available on Resource Watch, which incorporate the emission trajectories from the SSPs, we defined a projection of 0.5 m (the most optimistic temperature rise scenario under SSP1-1.9) to visualize the large and megacities that will be affected by sea level rise.

The identified cities were then cross-checked with information on migration destinations [42]. The results of this convergence analysis were spatialized using geoprocessing and spatial analysis to show the impact of sea level rise on large and megacities as migration destinations.

Next, for the cities identified as susceptible to sea level rise, an integrated analysis was carried out, which considered their location within one of the biodiversity hotspots [43,44] and as a hotspot city [25]. A geoprocessing approach was used to overlay these variables on a geographic information system (GIS), which made it possible to identify the urban areas where these vulnerabilities overlap.

We define the concept of "Climate Emergency Coastal Cities" as urban agglomerations with more than five million inhabitants located in coastal regions that face high vulnerability to climate risks, especially sea level rise. They are characterized by a combination of four selected factors that define their socio-environmental vulnerability: (i) high exposure to sea level rise, (ii) location within a biodiversity hotspot, (iii) importance as a destination for migratory flows, and (iv) exhibiting conflicts between urban growth and biodiversity conservation (hotspot city). Considering exposure to sea level rise as a line, the classification is based on the presence or absence of these factors, which result in four levels of climate emergency. The emergency levels are: Concerning (one factor); High (two factors); Very High (three factors); and Extreme (all four factors present). This categorization captures the compound risks and guides prioritization for climate adaptation and mitigation strategies.

The thresholds associated with each criterion have been defined to ensure consistency in the classification. A city is classified in one of the Coastal Climate Emergency categories if it meets one or more of the following thresholds:

- Vulnerability to sea level rise: projected sea level rise of at least 0.5 m by 2100.
- Biodiversity hotspots: Biodiversity hotspots are defined as geographical regions where exceptional concentrations of endemic species suffer from exceptional habitat loss [45]. Although the thirty-six global biodiversity hotspots cover only 2.5% of the Earth's surface, they are home to more than half of all endemic species of terrestrial plants and vertebrates [46]. The increase in human population density has been identified as one of the greatest threats to biodiversity [46–49]. As the main driver of biodiversity loss is the rapid destruction of pristine habitats around the world [46], for this criterion, we defined that the urban agglomeration must be located in one of the thirty-six recognized biodiversity hotspots [50].
- Conflict between urbanization and biodiversity: as losses in global biodiversity hotspots are not evenly distributed [46], this criterion identifies cities where urbanization is occurring in direct conflict with threatened species on a global scale [25].
- Migration destination: cities listed in the World Migration Report (2015) of the International Organization for Migration [42].

Depending on the presence or absence of one or more analysis factors, we define that Climate Emergency Coastal Cities can be classified into four categories (Figure 1):

1. Extreme Climate Emergency: Vulnerable to sea level rise | Migratory destination | Biodiversity hotspot | Hotspot city.
2. Very High Climate Emergency: Vulnerable to sea level rise | Migratory destination | Biodiversity hotspot.
3. High Climate Emergency: Vulnerable to sea level rise | Migratory destination or Biodiversity hotspot.
4. Concerning Climate Emergency: Vulnerable to sea level rise.

This analytical framework for classifying Climate Emergency Coastal Cities is based on a theoretical and empirical framework that integrates social and environmental factors. Social factors have been directly incorporated into the methodology with the identification of cities that are migratory destinations, whose flows reflect broad socio-economic dynamics that shape trends in population growth and urban resilience. Migration is therefore an analytical axis that connects exposure to sea level rise to socio-economic pressures. Additionally, although conflicts between urbanization and biodiversity are predominantly characterized as an environmental factor, this criterion has a significant social component that influences the socio-environmental vulnerability of a city and its implications for migration, governance, and urban planning.

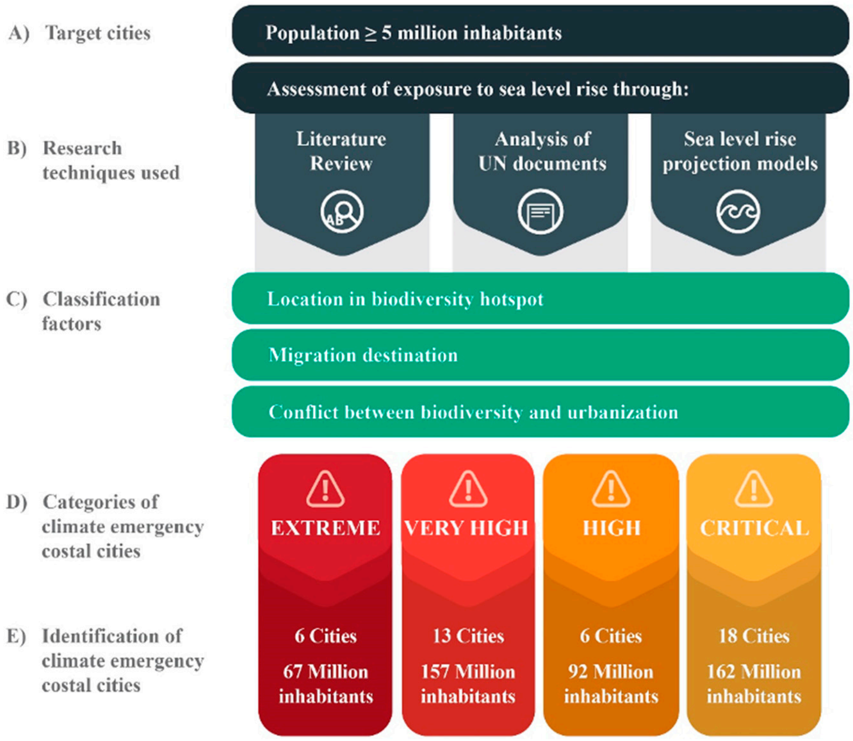

Figure 1. Diagram showing the workflow.

This classification reflects the exposure to sea level rise and the degree of socio-environmental vulnerability to the occurrence or not of the factors analyzed, the details of each aspect of which are discussed in the next section. By employing this classification, different strategies can be used to assist in the long-term planning process for human settlements, risk prevention, land use decisions, and resource targeting.

3. Results and Discussion

In large and megacities worldwide, anthropogenic pressures, including land use change, interact with climate change, resulting in complex and non-linear responses in biodiversity and human mobility [3,6,24], compromising response options to GCC-related challenges. Particularly in coastal areas, population concentration causes serious damage to ecosystems, social problems, conflicts, and loss of important ecosystem services due to rapid development, high population densities, and consumption rates [7,51].

Analyzing the complex interactions between coastal large and megacities and the environment, key components emerge, such as urbanization, energy consumption, transportation, industry, agriculture, water consumption, and tourism [51]. These interactions manifest as drives, pressures, states, and impacts, revealing obstacles to implementing global development policies in large coastal urban agglomerations. The recent intense coastal zone development and impending widespread GCC impacts significantly increase associated economic, social, and environmental risks, necessitating a comprehensive understanding to formulate effective response strategies [33,52].

The choice of a simplified classification system to analyze the vulnerabilities of large coastal cities reflects both a pragmatic and scientific need to make accessible the most critical factors influencing urban resilience in the face of climate change. Although complexity is characteristic of these interactions, a simplified classification system can facilitate their application and rapid identification of priority areas for resource allocation in planning contexts. At the same time, this system helps to ensure that the highest risk factors are highlighted and dealt with effectively.

Reviews on sustainability and climate resilience in coastal large and megacities reveal a focus on flood modeling and hydrological infrastructure, with gaps in long-term planning and social dimensions, notably in developing and middle-income countries [13]. Furthermore, the complexity of interrelationships between population, infrastructure, and institutions presents challenges, requiring broader, more integrated approaches [31].

Various vulnerability indices have been proposed and tested, focusing on local or regional perspectives, such as the Coastal City Flood Vulnerability Index (CCFVI) and assessments in cities like Surat, Mumbai, Chennai, and Kolkata [21,23]. These indices aim to address the exposure of coastal cities to major storms and future inundation zones, emphasizing the need for localized, context-specific approaches [10,53].

Recognizing Climate Emergency Coastal Cities

For the 81 large and megacities with populations above five million people, we applied the concept of Climate Emergency Coastal Cities, based on the assessment of the relationship between cities and biodiversity in the context of long-term transformations in temperature and climate patterns. We identify cities directly affected by sea level rise at a projection of 0.5 m rise under the most optimistic temperature increase scenario. Of the 81 cities subject to this study, we defined 43 as Climate Emergency Coastal Cities. Then, these cities affected by the rise of the ocean were classified according to their level of socio-environmental vulnerability, with those that presented a greater number of analysis factors being categorized as more critical (Figure 2).

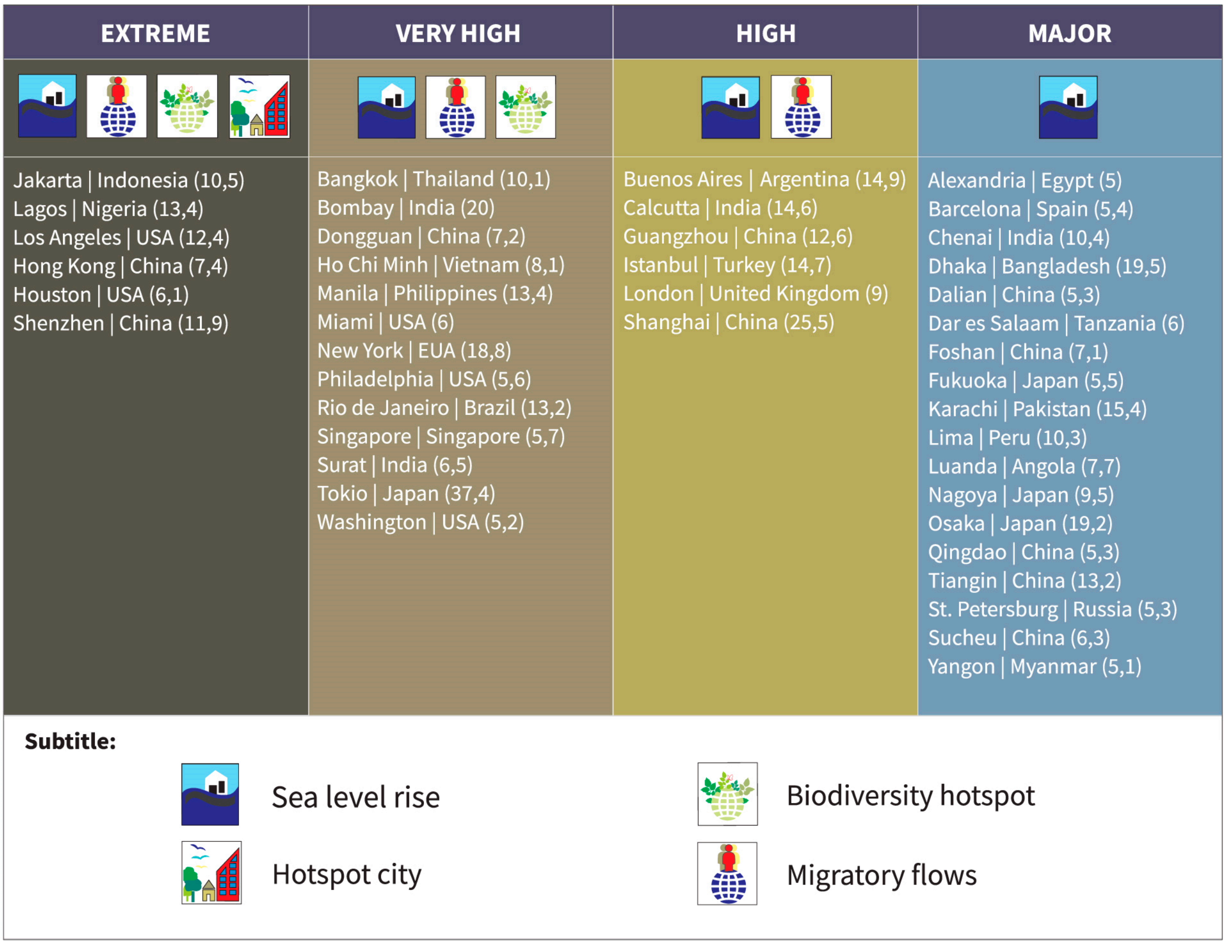

Figure 2. Classification of large and megacities and their respective populations in parentheses.

The cities of Lagos (Nigeria), Jakarta (Indonesia), Los Angeles and Houston (USA), and Hong Kong and Shenzhen (China) are classified as Extreme Climate Emergency Coastal Cities. This classification is due to their geographical location, high population density, and significant urbanization in environmentally sensitive areas. Located in biodiversity hotspots, these cities are migration destinations and add up to about 62 million people exposed to the impacts of climate change.

With less conflict between their urban growth and the biodiversity harbored within their territory, the following cities were classified as Very High Climate Emergency Coastal Cities: Bangkok (Thailand); Mumbai and Surat (India); Dongguan (China); Philadelphia, Miami, New York, and Washington, D.C. (USA); Ho Chi Minh City, (Vietnam); Manila, (Philippines); Rio de Janeiro (Brazil); Singapore, (Singapore); and Tokyo (Japan), totaling about 157 million inhabitants. The cities of Buenos Aires (Argentina); Calcutta (India); Guangzhou and Shanghai (China); Istanbul (Turkey); and London (United Kingdom), with around 92 million inhabitants, were classified as High Climate Emergency Coastal Cities, for their vulnerability to rising sea levels and being a migratory destination.

In addition, the large and megacities of Alexandria (Egypt); Barcelona (Spain); Chennai (India); Dhaka (Bangladesh); Dalian, Foshan, Qingdao, Sucheu, and Tianjin (China); Dar es Salaam (Tanzania); Fukuoka, Nagoya and Osaka (Japan); Karachi (Pakistan); Lima (Peru); Luanda (Angola); Yangon (Myanmar); and St. Petersburg (Russia), with a population of around 162 million inhabitants, were classified as Critical Climate Emergency Coastal Cities because they are affected by the rise in sea level.

Cities in both the Global North and South present critical prospects regarding sea level rise and potential demographic increases. Countries in the Global South present fragile economic situations with numerous governance challenges, making the relationships between migration and urban structuring even more complex [54,55]. Of the total Climate Emergency Coastal Cities, 65.1% belong to the Global South, with the 'extreme' and 'very high' levels of Climate Emergency being more balanced between cities in both classifications. The United States and China are the countries that have two cities each in the most severe climate emergency levels.

Since 2015, with the adoption of various international agreements, cities have been recognized as key elements in global development policies. The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals, the Paris Agreement, the New Urban Agenda, the Sendai Framework for Disaster Risk Reduction, and the Addis Ababa Action Agenda constitute the main axis of international development policy, with recommendations, goals, targets and indicators and broad recognition of the role of local governments [5,38].

As climate risk is a product of both increased environmental shocks and stresses, as well as social, political, and cultural factors, vulnerable countries, communities, and low-income and marginalized groups will suffer disproportionately from the impacts of climate change [56]. Climate justice, in this context, involves international financial response mechanisms related to both loss and damage (L&D) and adaptation finance. These have as a critical component the redistribution of resources from countries that have driven global warming to those that experience or are likely to experience the most severe effects of climate change. However, in general, most of the funding is managed by multilateral organizations and national entities and governments, so only a small proportion of resources are channeled to the local level, let alone to locally designed and led resilience initiatives [35,57]. Furthermore, as populist movements severely affect climate policy in the long run, engaging with populist climate politics needs to respond to local contexts and distinguish between the economic, anti-elitist, and knowledge foundations it is intertwined with [58] more seriously.

When considering that a more sustainable and resilient urban future will be within, rather than outside local democracies [4,39], resourcing and empowering local civil society groups and local government can be instrumental in reducing vulnerability and improving capacity to reduce risk exposure [35]. This perspective places human development at the heart of the climate change issue, which irrevocably has equity as a fundamental requirement to address the multifaceted challenges of the GCC [36].

It is certain that future efforts, especially for Climate Emergency Coastal Cities, should prioritize coordinated actions for climate change mitigation that simultaneously provide for the protection of biodiversity in coastal zones and coral reefs. These ecosystems are responsible for absorbing atmospheric carbon and are of utmost importance for biodiversity conservation and provision of local ecosystem services, such as mitigating the impacts of floods and storms, reducing water runoff, and hence, slope erosion, with the potential to save lives and prevent material and immaterial damages. However, the degradation of these ecosystems is continuously increasing; it is estimated that 87% of the planet's total wetlands have been lost in the last 300 years and 35% since 1970.

As responses to sea level rise impacts are dynamic and sensitive to landscape changes [59], early warning systems combined with information technology should be effectively implemented in risk management and adaptation strategies [21] and adaptive actions should be driven by a bottom-up participatory approach involving stakeholders from public, private and non-governmental organizations [10]. Similarly, we find that co-created information on risk elements, from inclusive and participatory data collection approach involving local knowledge, is crucial for decision-making on areas that should be prioritized for protection [60]; greater engagement of health systems (public and private) with emergency management and urban and regional planners is needed, as well as advances in integrating climate-sensitive coastal hazards and emergency management into public health and water infrastructure for exposure reduction and disaster recovery [22]. Evidence pointed to increased recognition of the interdependent nature of climate change, biodiversity, and human well-being [28], the crucial role of developing robust strategies, with the continuous innovation of policymaking and management institutions, and intensified knowledge exchange between science and society [31], as well as the urgency of directing international assistance towards the effective and equitable allocation of resources for coastal protection and disaster prevention [35,53].

In large and megacities worldwide, anthropogenic pressures, including land use change, interact with climate change, resulting in complex and non-linear responses in biodiversity and human mobility [3,6,24], compromising response options to GCC-related challenges. Particularly in coastal areas, population concentration causes serious damage to ecosystems, social problems, conflicts, and loss of important ecosystem services due to rapid development, high population densities, and consumption rates [7,51].

As Climate Emergency Coastal Cities must deal in the coming decades with slow onset changes, including increasing frequency and magnitude of extreme events and intensifying sea level rise, public policies based on integrated urban and territorial planning are needed, with the adoption of managed retreats for the strategic relocation of goods and people away from risk areas.

For these cities, good governance that encompasses effective leadership, jurisdictional and multilevel coordination, inclusive citizen participation, and adequate funding is fundamental to the development of sustainable, resilient, and inclusive cities is something that still faces barriers, especially in countries of the Global South [11,54]. It is worth mentioning that the adaptive capacity of each city differs according to its needs and structures. The most vulnerable cities do not have access to the set of actions and measures necessary to increase their resilience to the adversities of the physical environment. However, it is reinforced that Climate Emergency Coastal Cities, especially those located in the Global South, should invest in transformative rather than incremental adaptation, with stakeholders in the coordination of common interests and the pursuit of social equity to minimize urban inequalities that characterize a picture of climate injustice [61,62]. As 58% of Climate Emergency Cities are migration destinations, coordinated and multidimensional action for inflows and outflows is essential to reduce risks and vulnerabilities and build stronger, more resilient communities.

With almost half a billion people, the classification of 43 major cities as Climate Emergency Coastal Cities provides another look at a changing world in the face of intensifying climate change impacts, which requires a dynamic perspective on the approach. Thus, as this study considered a certain scenario in relation to sea level rise, changes in this projection due to changes in temperature rise and biogeochemical factors related to climate change can lead to differentiated coastal impacts on a greater or lesser number of urban agglomerations. Similarly, the classification of urban agglomerations as Climate Emergency Coastal Cities will need to be revised to incorporate new cities that have established themselves or are projected to become large and megacities in a given time horizon. Although this classification is an important tool to direct resources and research to these locations that are home to millions of people, as it is a macro-level classification, the specificities of these cities have not been addressed here and require specific studies to adequately guide response options at the local scale.

Future research can also expand the application of the model, offering a simplified classification directed to small towns and villages, in auto evaluation processes similar to the categorization developed in this study. With a broader perspective, this adapted model could be globally applied, contributing to a more qualified performance of planners in current and future scenarios.

4. Conclusions

Climate and environmental displacement and urbanization are major challenges to society and key issues in the international policy agenda. The trend of climate risks as a concrete and growing threat to human well-being and the health of the planet are factors for humanitarian crises arising from disasters and violent conflicts that drive migration and involuntary displacement of vulnerable populations. The study developed the concept of Climate Emergency Coastal Cities to assess the criticality of large and megacities in urban management and territorial planning amid climate change, focusing on 43 cities. Findings indicate that cities in the Global South are more vulnerable, highlighting social inequality and governance issues as barriers to adaptation. It emphasizes the need for integrated urban and territorial planning policies, considering various perspectives and coordinated actions. These policies should address marginalized urban groups and promote the inclusion of migrants in local social networks for effective adaptation measures.

In a highly urbanized and globalized world, international migrants represent more than a third of the population in many cities, and in some world centers, they significantly outnumber the local population. To develop a broad assessment of the criticality of large and megacities in terms of urban management and territorial planning in the face of climate change, the Climate Emergency Coastal Cities concept was defined, encompassing 43 cities that were classified at the Extreme (n = 6), Very high (n = 13), High (n = 6), and Concerning (n = 18) levels. Lagos, Los Angeles, Houston, Shenzhen, Hong Kong, and Jakarta, followed by Tokyo, Mumbai, Surat, New York, Miami, Philadelphia, Washington, D.C., Manila, Rio de Janeiro, Bangkok, Ho Chi Minh City, Dongguan, and Singapore, are the coastal megacities most vulnerable to climate change since urban growth processes occur in areas of high biodiversity.

The results of this study show a greater vulnerability of the Global South. Based on existing literature, social inequality and governance constraints constitute common barriers to climate adaptation, as socioeconomic disparities and inadequate governance structures are often associated with lower adaptive capacity in urban contexts. While more research is needed to establish causality, our findings align with documented trends showing that cities with greater social inequality and governance challenges tend to face greater difficulties in implementing comprehensive adaptation measures. For Climate Emergency Coastal Cities, it is essential to develop policies based on integrated urban and territorial planning, considering multiple perspectives and coordinated actions. These measures should encompass marginalized urban groups and promote the inclusion of migrants within the local social network. In parallel, it is necessary to structure responses that simultaneously promote human well-being, recovery of coastal ecosystems, and mitigation of climate change, with the identification of risk sites for the managed removal of human structures and implementation of measures to rehabilitate these urbanized coastal ecosystems, in order to meet various global biodiversity, climate, and sustainable development objectives and increase the contributions of local nature to people. A noted limitation of the proposed categorization is the challenge of considering the cumulative legacy of 500 years of Euro-American colonialism, imperialism, and capitalism, and the resulting socioeconomic, political, and geographical inequalities.

Considering that, a next step of the research is to look at the Climate Emergency Coastal Cities identified in this study under a climate justice lens. By foregrounding the ethical, social, and political dimensions of climate change impacts and responses, particularly in urban areas, a climate justice perspective in urban planning studies fosters more inclusive, equitable, and sustainable approaches to addressing the complex challenges of climate change in urban areas.

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References

1. Dijkstra, L.; Florczyk, A.J.; Freire, S.; Kemper, T.; Melchiorri, M.; Pesaresi, M.; Schiavina, M. Aplicando o grau de urbanização ao globo: Uma nova definição harmonizada revela uma imagem diferente da urbanização global. *J. Urban Econ.* **2021**, *125*, 103312. [CrossRef]
2. UN-Habitat. *World Cities Report 2022: Envisaging the Future of Cities*; UN-Habitat: Nairobi, Kenya, 2022; 422p, Available online: https://unhabitat.org/sites/default/files/2022/06/wcr_2022.pdf (accessed on 17 July 2023).
3. IPBES. *Scientific Outcome of the IPBES-IPCC Co-Sponsored Workshop on Biodiversity and Climate Change*; IPBES Secretariat: Bonn, Germany, 2021; Available online: https://boris.unibe.ch/185025/ (accessed on 9 July 2024).
4. Rodrigues, E.A.; Carvalho, A.R.; Carvalho, B.R.; Aquino, A.R.; Mendon√ßa, R.A.A.; Sodré, M.G. Megacities, climate vulnerability and environmental displacement: Interdependent Challenges. In Proceedings of the 2nd International Conference on Water, Megacities Global Change, Paris, France, 11–14 January 2022; Volume 14–15, pp. 1149–1159.
5. Rodrigues, E.A.; Ferreira, M.L.; de Carvalho, A.R.; Bustillos, J.O.W.V.; Victor, R.A.B.M.; Sodré, M.G.; de Andrade, D. A. Land, Water, and Climate Issues in Large and Megacities under the Lens of Nuclear Science: An Approach for Achieving Sustainable Development Goal (SDG11). *Sustainability* **2022**, *14*, 13646. [CrossRef]
6. IPCC. Climate Change 2023: Synthesis Report. Summary for Policymakers. In *Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Core Writing Team, Lee, H., Romero, J., Eds.; IPCC: Geneva, Switzerland, 2023; 36p, In Press; Available online: www.ipcc.ch (accessed on 8 June 2023).
7. Barragán, J.M.; de Andrés, M. Analysis and trends of the world's coastal cities and agglomerations. *Ocean. Coast. Manag.* **2015**, *114*, 11–20. [CrossRef]
8. Pelling, M.; Blackburn, S. *Megacities and the Coast: Risk, Resilience and Transformation*, 1st ed.; Earthscan from Routledge: Abington, UK, 2023; 272p. [CrossRef]

9. IPCC. *Climate Change 2022: Impacts, Adaptation and Vulnerability: Summary for Policymakers*; Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers; IPCC: Geneva, Switzerland, 2022; Available online: www.ipcc.ch (accessed on 8 June 2023).
10. Rouleau, T.; Stuart, J.; Call, M.; Yozell, S.; Yoshioka, N.; Maekawa, M.; Fiertz, N. The climate and ocean risk vulnerability index: Measuring coastal city resilience to inform action. *Front. Sustain. Cities* **2022**, *127*, 884212. [CrossRef]
11. UN. *Progress in the Implementation of the New Urban Agenda: Report of the Secretary-General*; A/76/639-E/2022/10; General Assembly Economic and Social Council: New York, NY, USA, 2022; Available online: https://digitallibrary.un.org/record/3964578 (accessed on 8 June 2023).
12. McAuliffe, M.; Triandafyllidou, A. (Eds.) *World Migration Report 2022*; Int. Organ. Migr. (IOM): Geneva, Switzerland, 2023; Available online: https://publications.iom.int/books/world-migration-report-2022 (accessed on 8 June 2024).
13. Graells, G.; Nakamura, N.; Celis-Diez, J.L.; Lagos, N.A.; Marquet, P.A.; Pliscoff, P.; Gelcich, S. A review on coastal urban ecology: Research gaps, challenges, and needs. *Front. Mar. Sci.* **2021**, *8*, 617897. [CrossRef]
14. Blythe, J.; Armitage, D.; Alonso, G.; Campbell, D.; Dias, A.C.E.; Epstein, G.; Marschke, M.; Nayak, P. Frontiers in coastal well-being and ecosystem services research: A systematic review. *Ocean. Coast. Manag.* **2020**, *185*, 105028. [CrossRef]
15. Fashae, O.A.; Onafeso, O.D. Impact of climate change on sea level rise in Lagos, Nigeria. *Int. J. Remote Sens.* **2011**, *32*, 9811–9819. [CrossRef]
16. Zhang, H.; Wu, C.; Chen, W.; Huang, G. Assessing the impact of climate change on the waterlogging risk in coastal cities: A case study of Guangzhou, South China. *J. Hydrometeorol.* **2017**, *18*, 1549–1562. [CrossRef]
17. Zhang, Q.; Wu, Z.; Tarolli, P. Investigating the role of green infrastructure on urban waterlogging: Evidence from metropolitan coastal cities. *Remote Sens.* **2021**, *13*, 2341. [CrossRef]
18. Tapia, C.; Abajo, B.; Feliu, E.; Mendizabal, M.; Martinez, J.A.; Fernández, J.G.; Laburu, T.; Lejarazu, A. Profiling urban vulnerabilities to climate change: An indicator-based vulnerability assessment for European cities. *Ecol. Indic.* **2017**, *78*, 142–155. [CrossRef]
19. Abadie, L.M.; Sainz de Murieta, E.; Galarraga, I. Climate risk assessment under uncertainty: An application to main European coastal cities. *Front. Mar. Sci.* **2016**, *3*, 265. [CrossRef]
20. Fernández-Díaz, V.Z.; Turriza, R.C.; Castilla, A.K.; Arreguín-Rodríguez, G.J.; Mejía-Piña, K.G. Impact of Sea Level Rise and Flooding in Two Key Mexican Coastal Cities. *Ocean. Yearb. Online* **2022**, *36*, 139–157. [CrossRef]
21. Dhiman, R.; VishnuRadhan, R.; Eldho, T.I.; Inamdar, A. Flood risk and adaptation in Indian coastal cities: Recent scenarios. *Appl. Water Sci.* **2019**, *9*, 5. [CrossRef]
22. Allen, T.R.; Crawford, T.; Montz, B.; Whitehead, J.; Lovelace, S.; Hanks, A.D.; Christensen, A.R.; Kearney, G.D. Linking water infrastructure, public health, and sea level rise: Integrated assessment of flood resilience in coastal cities. *Public Work. Manag. Policy* **2019**, *24*, 110–139. [CrossRef]
23. Balica, S.F.; Wright, N.G.; Van der Meulen, F. A flood vulnerability index for coastal cities and its use in assessing climate change impacts. *Nat. Hazards* **2012**, *64*, 73–105. [CrossRef]
24. McLeman, R. Thresholds in climate migration. *Popul. Environ.* **2018**, *39*, 319–338. [CrossRef]
25. Weller, R.; Drozdz, Z.; Kjaersgaard, S.P. Hotspot cities: Identifying peri-urban conflict zones. *J. Landsc. Archit.* **2019**, *14*, 8–19. [CrossRef]
26. Douglas, I.; Anderson, P.M.L.; Goode, D.; Houck, M.C.; Maddox, D.; Nagendra, H.; Tan, P.Y. (Eds.) *The Routledge Handbook of Urban Ecology*, 2nd ed.; Routledge: Abington, UK, 2020. [CrossRef]
27. Alamgir, M.; Pert, P.L.; Turton, S.M. A review of ecosystem services research in Australia reveals a gap in integrating climate change and impacts on ecosystem services. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2014**, *10*, 112–127. [CrossRef]
28. Baldwin-Cantello, W.; Tickner, D.; Wright, M.; Clark, M.; Cornelius, S.; Ellis, K.; Francis, A.; Ghazoul, J.; Gordon, J.E.; Matthews, N.; et al. The Triple Challenge: Synergies, trade-offs and integrated responses for climate, biodiversity, and human wellbeing goals. *Clim. Policy* **2023**, *23*, 782–799. [CrossRef]
29. Ali, S.; Xu, H.; Xu, P.; Ahmed, W. Evolutional attitude based on option prioritization for conflict analysis of urban transport planning in Pakistan. *J. Syst. Sci. Syst. Eng.* **2019**, *28*, 356–381. [CrossRef]
30. Ali, S.; Xu, H.; Ahmed, W.; Ahmad, N.; Solangi, Y.A. Metro design and heritage sustainability: Conflict analysis using attitude based on options in the graph model. *Environ. Dev. Sustain.* **2020**, *22*, 3839–3860. [CrossRef]
31. Ruth, M.; Coelho, D. Understanding and managing the complexity of urban systems under climate change. *Clim. Policy* **2007**, *7*, 317–336. [CrossRef]
32. Brinke, N.; Kruijf JV, D.; Volker, L.; Prins, N. Mainstreaming climate adaptation into urban development projects in the Netherlands: Private sector drivers and municipal policy instruments. *Clim. Policy* **2022**, *22*, 1155–1168. [CrossRef]
33. Arthurton, R.S. Marine-related physical natural hazards affecting coastal megacities of the Asia-Pacific region-awareness and mitigation. *Ocean. Coast. Manag.* **1998**, *40*, 65–85. [CrossRef]
34. Castells-Quintana, D.; Wenban-Smith, H. Population Dynamics, Urbanization without Growth, and the Rise of Megacities. *J. Dev. Stud.* **2020**, *56*, 1663–1682. [CrossRef]
35. Colenbrander, S.; Dodman, D.; Mitlin, D. Using climate finance to advance climate justice: The politics and practice of channeling resources to the local level. *Clim. Policy* **2018**, *18*, 902–915. [CrossRef]

36. Klinsky, S.; Winkler, H. Equity, sustainable development and climate policy. *Clim. Policy* **2014**, *14*, 1–7. [CrossRef]
37. Heyen, D.A. Social justice in the context of climate policy: Systematizing the variety of inequality dimensions, social impacts, and justice principles. *Clim. Policy* **2022**, *23*, 539–554. [CrossRef]
38. Ferreira, M.L.; Dalmas, F.B.; Santanna, M.; Rodrigues, E.A.; Sodré, M.G. Sustainable development in S√£o Paulo's Green Belt Biosphere Reserve: Between the void of municipal environmental policies and the ecosystem management of the territory. *Rev. Gestao Ambient. Sustentabilidade-Geas* **2023**, *12*, e22940. [CrossRef]
39. Ferreira, M.L.; Kniess, C.T.; Silva, W.M.; Ferreira, A.T.D.S. Urban Forests, Territorial Planning and Political Stability: Key Factors to Face Climate Change in a Megacity. *Sustainability* **2023**, *15*, 10092. [CrossRef]
40. Resource Watch. Monitoring the Planet's Pulse. 2023. Available online: https://resourcewatch.org/ (accessed on 17 July 2023).
41. IPCC. *Climate Change 2021: The Physical Science Basis: Summary for Policymakers*; Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Masson-Delmotte, V.P., Ed.; Cambridge University Press: Cambridge, UK, 2021; Available online: www.ipcc.ch (accessed on 8 June 2023).
42. IOM. *World Migration Report 2015: Migrants and Cities: New Partnerships to Manage Mobility*; IOM: Geneva, Switzerland, 2015; 227p, Available online: https://publications.iom.int/system/files/pdf/wmr2015_en.pdf (accessed on 8 June 2023).
43. Trew, B.T.; Maclean, I.M. Vulnerability of global biodiversity hotspots to climate change. *Glob. Ecol. Biogeogr.* **2021**, *30*, 768–783. [CrossRef]
44. Kong, X.; Zhou, Z.; Jiao, L. Hotspots of land-use change in global biodiversity hotspots. *Resour. Conserv. Recycl.* **2021**, *174*, 105770. [CrossRef]
45. Myers, N.; Mittermeier, R.A.; Mittermeier, C.G.; Da Fonseca, G.A.; Kent, J. Biodiversity hotspots for conservation priorities. *Nature* **2000**, *403*, 853–858. [CrossRef] [PubMed]
46. Habel, J.C.; Rasche, L.; Schneider, U.A.; Engler, J.O.; Schmid, E.; Rödder, D.; Meyer, S.T.; Trapp, N.; del Diego, R.S.; Eggermont, H.; et al. Final countdown for biodiversity hotspots. *Conserv. Lett.* **2019**, *12*, e12668. [CrossRef]
47. McDonald, R.I.; Marcotullio, P.J.; Güneralp, B. Urbanization and global trends in biodiversity and ecosystem services. In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment*; Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P.J., McDonald, R.I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C., et al., Eds.; Springer Nature: Berlin/Heidelberg, Germany, 2013; pp. 31–52+755.
48. Venter, O.; Sanderson, E.W.; Magrach, A.; Allan, J.R.; Beher, J.; Jones, K.R.; Possingham, H.P.; Laurance, W.F.; Wood, P.; Fekete, B.M.; et al. Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. *Nat. Commun.* **2016**, *7*, 12558. [CrossRef]
49. Cunningham, C.; Beazley, K.F. Changes in human population density and protected areas in terrestrial global biodiversity hotspots, 1995–2015. *Land* **2018**, *7*, 136. [CrossRef]
50. Critical Ecosystem Partnership. Biodiversity Hotspots Defined. 2016. Available online: https://www.cepf.net/our-work/biodiversity-hotspots/hotspots-defined (accessed on 2 September 2018).
51. Sekovski, I.; Newton, A.; Dennison, W.C. Megacities in the coastal zone: Using a driver-pressure-state-impact-response framework to address complex environmental problems. *Estuar. Coast. Shelf Sci.* **2012**, *96*, 48–59. [CrossRef]
52. Johnston, A.; Slovinsky, P.; Yates, K.L. Assessing the vulnerability of coastal infrastructure to sea level rise using multi-criteria analysis in Scarborough, Maine (USA). *Ocean. Coast. Manag.* **2014**, *95*, 176–188. [CrossRef]
53. Brecht, H.; Dasgupta, S.; Laplante, B.; Murray, S.; Wheeler, D. Sea-level rise and storm surges: High stakes for a small number of developing countries. *J. Environ. Dev.* **2012**, *21*, 120–138. [CrossRef]
54. Wamsler, C.; Wickenberg, B.; Hanson, H.; Olsson, J.A.; Stålhammar, S.; Björn, H.; Falck, H.; Gerell, D.; Oskarsson, T.; Simonsson, E.; et al. Environmental and climate policy integration: Targeted strategies for overcoming barriers to nature-based solutions and climate change adaptation. *J. Clean. Prod.* **2020**, *247*, 119154. [CrossRef]
55. FCSSC Finance Center For South-South Cooperation. Organization in Special Consultative Status with ECOSOC of the United Nations. 2023. Available online: http://www.fc-ssc.org/en/about_us/background (accessed on 29 November 2024).
56. Ferreira, M.L. Extreme rain event highlights the lack of governance to face climate change in the Southeastern coast of Brazil. *Geogr. Sustain.* **2024**, *5*, 29–32. [CrossRef]
57. Lai, M.; Robinson, S.A.; Salas, E.; Thao, W.; Shorb, A. Climate justice for small island developing states: Identifying appropriate international financing mechanisms for loss and damage. *Clim. Policy* **2022**, *22*, 1213–1224. [CrossRef]
58. Marquardt, J.; Oliveira, M.C.; Lederer, M. Same, same but different? How democratically elected right-wing populists shape climate change policymaking. *Environ. Politics* **2022**, *31*, 777–800. [CrossRef]
59. Bilskie, M.V.; Hagen, S.C.; Medeiros, S.C.; Passeri, D.L. Dynamics of sea level rise and coastal flooding on a changing landscape. *Geophys. Res. Lett.* **2014**, *41*, 927–934. [CrossRef]
60. Ogie, R.I.; Holderness, T.; Dunn, S.; Turpin, E. Assessing the vulnerability of hydrological infrastructure to flood damage in coastal cities of developing nations. *Comput. Environ. Urban Syst.* **2018**, *68*, 97–109. [CrossRef]

61. Levy, B.S.; Patz, J.A. Climate change, human rights, and social justice. *Ann. Glob. Health* **2015**, *81*, 310–322. [CrossRef]
62. Fedele, G.; Donatti, C.I.; Harvey, C.A.; Hannah, L.; Hole, D.G. Transformative adaptation to climate change for sustainable social-ecological systems. *Environ. Sci. Policy* **2019**, *101*, 116–125. [CrossRef]