# *The* CHANGING WEALTH *of* NATIONS

2024

## TECHNICAL REPORT

## Building Coastal Resilience with Mangroves:

### The Contribution of Natural Flood Defenses to the Changing Wealth of Nations


WORLD BANK GROUP

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# Acknowledgements

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This report has drawn extensively on previous World Bank valuation work, including that the development of valuation guidelines for a comprehensive assessment of the coastal protection benefits derived from these natural assets led by Michael W. Beck and Glenn-Marie Lange and the practical implementation at the national level for mangroves in the Philippines and Jamaica (Menendez et al. 2018; Ortega et al. 2019). The authors also acknowledge past support in the development of this work from The Nature Conservancy, AXA Research Fund, and the Center for Coastal Climate Resilience. The report benefited from the thoughtful guidance and input of Stefanie Onder, Borja Gonzalez Reguero, and Alexis Rivera Ballesteros of the World Bank.

This technical report was produced as input to the upcoming Changing Wealth of Nations 2024 report. The Changing Wealth of Nations flagship series is produced by the World Bank and provides the most comprehensive accounting of the wealth of nations, an in-depth analysis of the evolution of wealth, and pathways to build wealth for the future. The flagship series—and the accompanying global database—firmly establishes comprehensive wealth as a measure of sustainability and a key component of country analytics. Each iteration expands the coverage of wealth accounts and improves our understanding of the quality of all assets, notably, natural capital. In addition, each report provides a new set of tools and analysis to help policy makers mainstream wealth and its components into economic analysis and guide decision-making at the country and global scale.

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# Executive summary

With the escalation of coastal risks caused by storms and climate change, the demand for coastal defenses is on the rise. Global studies using risk models (Beck et al. 2018; Menendez et al. 2020) have shown that mangroves and coral reefs can provide highly valuable coastal protection services by reducing waves and storm surges, and acting as a first line of defense against flooding and erosion. These natural coastal protection services were included for the first time in the 2021 edition of the World Bank's The Changing Wealth of Nations (CWON), which covered the changing value of mangroves as coastal protection assets from 1995–2015. Here, we have included new data for 2020 on global mangrove distribution, and assessed current flood risks and the benefits of mangroves in reducing floods. We also have re-analyzed historic flood risk and mangrove benefits (1995–2020) as there were updates to past ecological (mangrove distributions) and economic (Penn World Table (PWT)) data.

To evaluate the contribution of natural capital assets to the wealth of (sub)tropical nations, we use peer-reviewed models of flood risks and habitat benefits. Our approach uses a combination of process-based storm and hydrodynamic models, which are described in Menendez et al. 2020. Specifically, we use these models to determine the area and depth of flooding with and without mangroves for five storm frequency events (one storm in 5, 10, 25, 50, and 100 years), which are driven by local storm data. To assess the value of mangroves as natural capital assets, we overlay flood extent and depth data onto historical data on populations and asset values (PWT 10.0, (Feenstra et al. 2015)), adjusted to constant 2020 US dollars. This enables us to identify a probabilistic distribution of flood damage (risk) and the benefits of avoided damages (habitat benefits).

We assessed flood risk and mangrove benefits in 1996, 2010, 2015, and 2020 and evaluated changes in flood risks and mangrove benefits between these years. We assessed risks and mangrove benefits for 121 nations with mangroves covering about 700,000 kilometers (km) of (sub)tropical coastlines, 97 of which showed either economic or social benefits from mangroves. We summarize results by country, but these models and values can be used to understand risks and benefits within countries at the provincial and even municipal levels. These are fully quantitative risk models compared to other index-based approaches for assessing coastal vulnerability and ecosystem services.

The present value of the flood reduction benefits from mangroves (100-year assets at a 4 percent discount rate) in 2020 is $855 billion. The countries with the greatest present value of mangroves for flood reduction are China, Vietnam, Australia, the United States (US), and India (all countries here and after are listed in rank order). Annual flood risk on mangrove coastlines in 2020 is most significant in China, the US, Australia, Taiwan, and Vietnam. Each of these countries has more than 98,000 people exposed to coastal flooding yearly and more than $4.7 billion in assets at risk from flooding annually on mangrove coastlines. The increase in the wealth of mangroves for flood risk reduction from 1996–2010 was $130 billion, while from 2010–2020 the increase was $502 billion. The countries receiving the most significant increases in wealth in absolute values in 2020 (US dollars) were China, Vietnam, Australia, the US, and India, and in relative values (percent) were South Africa, Guyana, Vanuatu, Grenada, and St Lucie.

The period from 1996–2010 covers some of the most significant losses of mangroves in recorded history from the rapid expansion of shrimp aquaculture in the 2000s and the more consistent losses from coastal development. The global loss of mangroves was 4 percent from 1996–2010, but was more than 30 percent in some countries, such as Sudan, Turks and Caicos, Oman, Djibouti, and Sri Lanka. Over this period, the total mangrove loss in hectares (absolute value) was most significant in Indonesia, Mexico, Australia, Myanmar, and Cuba. From 1996–2010 annual coastal flood risk increased dramatically to people (32 percent) and property (122 percent). Multiple factors contributed to this increase, including mangrove loss (4 percent) and population increases (21 percent), and capital stock increases (72 percent) in these countries. Despite the loss of mangrove habitats, their flood reduction benefits (i.e., their value to national wealth) increased significantly. Mangroves protected 22 percent more people and 59 percent more capital stock value in 2010 than in 1996 because of increased populations and asset values in areas protected by mangroves. The countries receiving the most significant increase in mangrove flood reduction benefits to national wealth from 1996–2015 were Vietnam, China, Puerto Rico, India, and Indonesia.

Mangrove cover declined globally from 2010–2020, but the decrease was small overall (0.66 percent). The most significant gains in mangrove habitat were observed in Oman, Turks and Caicos Islands, Mauritania, Togo, and Djibouti, with an increase in cover of more than 10 percent. However, some countries still suffered loss rates higher than 10 percent, including Saudi Arabia, Taiwan, Sudan, Pakistan, and Jamaica. From 2010–2020, the annual coastal flood risk to people and property increased by 33 percent and 104 percent globally. These national increases in risk are created by the mangrove loss (0.66 percent) and increases in population (12 percent) and capital stock (40 percent). The countries with the most significant increases in people at flood risk were China, Vietnam, India, Bangladesh, and Indonesia (more than 347,000 people flooded/year/country). The countries with the most significant increases in economic risk were China, the US, Australia, Taiwan, and Vietnam (more than $2,700 million/year/country).

However, in the period 2010–2020, for the first time, mangrove benefits increased more than flood risk. Within this decade, more than 61 percent of people received direct flood benefits, and mangroves protect more than 109 percent of capital stock from coastal flooding. Vietnam, Bangladesh, India, China, and Cameroon experienced the most significant increase in people protected by mangroves (more than 147,000 people/year/country). Some countries experienced a decline in people protected by mangroves, including Malaysia, Myanmar, Taiwan, Pakistan, and Colombia. In economic terms, China, Vietnam, Australia, the US, and Bangladesh saw the most significant increases in mangrove flood protection benefits of more than $1,170 million/year. Jamaica, Timor Leste, Belize, and Pakistan experienced decreased mangrove benefits (a decrease of $0.8 million/year/country) in annual expected flood protection benefits from mangroves.

These results indicate that mangroves can have significant and highly valuable benefits for national flood risk reduction and climate adaptation. These values can be used to inform investments in the conservation, restoration, and management of these habitats.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **CWON** | Changing Wealth of Nations |
| **EU** | European Union |
| **GDP** | Gross domestic product |
| **GHS-POP** | Global Human Settlement population grid |
| **GMW** | Global Mangrove Watch |
| **IDB** | Inter-American Development Bank |
| **JRC** | Joint Research Centre |
| **KM** | Kilometer |
| **M** | Meter |
| **PV** | Present value |
| **PWT** | Penn World Table |
| **SEEA** | System of Environmental-Economic Accounting |
| **SNA** | System of National Accounts |
| **SRTM-DTM** | Shuttle Radar Topography Mission |
| **UNDRR** | United Nations Office for Disaster Risk Reduction |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **US** | United States |

# 1 Introduction

Rigorously evaluating flood reduction benefits and identifying where natural coastal defenses provide the most significant benefits can play an important role in informing policies for adaptation, sustainable development, and environmental restoration. Governments worldwide are investing billions of dollars in reducing the risks of flooding, erosion, and extreme weather events related to coastal development and climate change. However, most investments in coastal protection support "gray infrastructure"[1] that remains vulnerable to coastal risks and fails to adapt to changing environments. There is growing interest in nature-based defenses, as seen in significant attention from international bodies such as the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Office for Disaster Risk Reduction (UNDRR), the European Union (EU), and national and multinational agencies and organizations such as the Army Corps of Engineers, the World Bank, and the Inter-American Development Bank (IDB) (see Box 1.1).

## Box 1.1: Growing interest in nature-based defenses across international bodies

There is a growing interest in nature-based defenses from multiple international bodies. The Paris Agreement, for example, adopted under the UNFCCC, emphasizes the role of ecosystems and nature-based solutions in building resilience to climate change. The UNDRR, as part of the United Nations, focuses on reducing disaster risk and promoting resilience worldwide. The Sendai Framework for Disaster Risk Reduction, adopted by UN member states in 2015, highlights the significance of nature-based solutions in disaster risk reduction efforts. It encourages the integration of ecosystem-based approaches into disaster risk management strategies. The EU has various policies and initiatives promoting nature-based solutions. Its Biodiversity Strategy for 2030 aims to protect and restore ecosystems, including using nature-based solutions. The EU's Green Deal and the European Green Infrastructure Strategy also emphasize the role of nature-based approaches in achieving environmental sustainability and resilience.

The World Bank has been actively involved in promoting nature-based solutions in its projects and initiatives. It supports initiatives such as the Global Partnership for Oceans and the Forest Carbon Partnership Facility, which incorporate nature-based approaches in their strategies for sustainable development and climate action. The IDB focuses on promoting economic and social development in Latin America and the Caribbean. While it may not have specific agreements dedicated solely to nature-based defenses, the IDB has supported numerous projects and initiatives that incorporate nature-based solutions to address environmental challenges and enhance resilience in the region.

1 Gray infrastructure refers to structures such as dams, seawalls, roads, pipes, or water treatment plants.

The wealth accounts produced by the World Bank's CWON work program can be used to inform many policy decisions, including those on risk reduction, adaptation, development and natural resource management. The measurement of wealth is enhanced with each update of the CWON database by broadening the scope and improving the quality of all assets, with particular emphasis on natural capital and human capital. The five asset categories included in the comprehensive wealth accounts are produced capital, non-renewable natural capital, renewable natural capital, human capital, and net foreign assets.

Previous wealth estimates were limited in their assessment of renewable natural capital due to data limitations, with the focus being on agricultural land, forests, and protected areas. However, CWON 2021 expanded the coverage of renewable natural capital to include marine fisheries, a pilot account for renewable energy, and additional ecosystem services from forests, especially mangroves. The upcoming CWON 2024 report will build on the findings of CWON 2021 and extend the analysis further.

Recent global studies employing integrated ecological, engineering, and economic models have highlighted the crucial coastal protection services provided by mangroves and coral reefs (Beck et al. 2018; Menendez et al. 2020). In 2016, the World Bank formulated guidelines for a comprehensive assessment of the coastal protection benefits derived from these natural assets (Beck et al. 2016). These guidelines were successfully implemented and refined at the national level for mangroves in the Philippines and Jamaica (Menendez et al. 2018; Ortega et al. 2019) and have since been extended to assess the value of reefs and mangroves worldwide (Beck et al. 2018; Losada et al. 2018; Menendez et al. 2020). In 2021, the CWON report broke new ground by quantifying the value of mangrove assets over a period of two decades (1995 to 2015; Beck et al. 2022).

Mangroves play a crucial role in safeguarding coastlines by mitigating the risk of flooding and erosion. The aerial roots of mangroves act as a barrier to retain sediments, thereby preventing erosion. Moreover, the roots, trunks, and canopy of mangroves reduce the force of oncoming wind and waves, and this, in turn, mitigates the risk of flooding. According to the World Bank (2016), a 500-meter-wide mangrove forest can reduce wave heights by 50–100 percent in general, while during cyclones the reduction can go up to 60–90 percent (Narayan et al. 2010). This reduction in wave heights can result in relatively small reductions in water levels that can prevent property damage and flooding, particularly in low-lying areas. Mangroves contribute to long-term coastal stability by promoting sedimentation, decreasing erosion, and maintaining tidal channels. They also provide resources to support fisheries, building materials, ecotourism, and trade, thus promoting sustainable livelihoods and reducing social vulnerability.

Mangroves are natural barriers that provide crucial protection to people and property from storms. However, policy makers often fail to account for these benefits, leading to the continued loss of these habitats. At present, , losses from mangroves are not factored into decision-making. In addition, the benefits of managing or restoring coastal natural capital remain unrecognized.

We use new data on historical mangrove distributions from 1996 to 2020 to assess changes in the value of coastal protection benefits over time. Overall, 19 percent of the world's mangroves was lost between 1980 and 2005 (Spalding et al. 2010). Though the rate of loss has slowed over the past decade (according to Global Mangrove Watch data, Bunting et al. 2022), mangroves still face significant threats. When mangroves are degraded or destroyed, coastlines become more vulnerable to the destructive effects of waves and storm surges, putting more people and property at risk from storms, floods, and rising sea levels.

In this study, we applied a methodological approach to assess the value of shoreline protection services provided by mangroves. Our approach involved using global flood risk models to simulate the impact of waves and surge generated by tropical storms as they interacted with mangrove shorelines. Through this modeling, we evaluated the socioeconomic risk associated with flooding and quantified the flood protection service offered by mangroves. To capture temporal dynamics, we used mangrove extent layers from multiple time points, spanning the period from 1996–2020. By incorporating these temporal dimensions, we were able to measure how the asset value of mangroves changed over time, thus providing insights into the evolving importance of mangroves for shoreline protection.

The rest of this report is structured as follows:

The first section focuses on the methods employed in this study and provides a comprehensive description of the study domain. It outlines the specific approaches used to model the effect of waves and surge on mangrove shorelines, as well as the evaluation of the socioeconomic risk associated with flooding and the quantification of mangroves' flood protection service. It provides an overview of the main updates in data and models used in this new assessment. It highlights the advancements made in terms of data sources, methodologies, and modeling techniques, which contribute to a more robust evaluation of shoreline protection services.

The next section is dedicated to the datasets used in this assessment. It provides detailed descriptions of each dataset employed, including information on their sources, resolution, and temporal coverage. This section serves as a valuable reference for understanding the data underpinning the subsequent analyses, which is presented in the results section. The latter showcases the findings related to shoreline protection services provided by mangroves, highlighting key trends, spatial patterns, and temporal changes in asset value. The results shed light on the significance and effectiveness of mangroves as a natural defense against flooding.

Lastly, the discussion section engages in a comprehensive discussion of the results and methods employed in this assessment. It examines the implications of the findings, identifies potential limitations, and explores the strengths and weaknesses of the applied methodologies. This section facilitates a deeper understanding of the analysis and its implications. The final section concludes the report by providing key recommendations based on the findings and discussions. It offers actionable insights for policy makers, stakeholders, and practitioners involved in coastal management, disaster risk reduction, and climate adaptation. The recommendations aim to enhance the integration of shoreline protection services provided by mangroves into decision-making processes and promote sustainable practices for coastal resilience.

# 2 Methods

## 2.1 METHODS IN BRIEF

In this section we describe the methods and data sources for estimating flood risk, flood protection benefits, and the asset value of mangroves locally, nationally, and globally. The flood protection benefits provided by mangroves are assessed as the flood damages avoided to people and capital stock by keeping mangroves in place (Beck et al. 2018; Losada et al. 2017; Menendez et al. 2020; Beck et al. 2022). This section extensively relies on the findings and methodologies presented in the technical report for CWON 2021, published in 2022 by Beck et al. The detailed explanations and methodologies employed are extensively covered in Beck et al. 2022 and are reproduced here for completeness and to ensure a thorough understanding of the approach used in this study.

We couple offshore storm models with coastal process and flood models to measure the flooding that occurs: (i) with and without mangroves, (ii) under cyclonic and non-cyclonic storm conditions, (iii) by storm frequency (return period) across the globe. These flood extents and depths are used to estimate the annual expected flood damage to people and capital stock, and hence the expected benefits of mangroves in social (people protected) and economic terms (capital stock protected).

Our estimates are based on a set of global statistical models, hydrodynamic process-based models, and socioeconomic data. All these processes are grouped into five steps following the Averted Damages (Expected Damage Function) approach, commonly used in engineering and insurance sectors and recommended for the assessment of coastal protection services from habitats (Figure 2.1). This figure illustrates the process of estimating the flood protection benefits provided by mangroves. It starts with assessing offshore dynamics and sea states, then considers nearshore hydrodynamics and their impact on waves. The figure highlights the role of mangroves as habitat and their effect on reducing wave run-up. It further extends to estimating flood heights inland for different return periods, comparing scenarios with and without mangroves. Finally, the consequences of flooding, including land damage, affected population, and built capital, are evaluated. Many aspects of these models such as connections between wind, waves, run-up, and flooding have been extensively validated (Menéndez et al. 2018, 2019; Menéndez et al. 2020).

We first developed key mangrove-specific aspects of the flood models in the Philippines, a country with over 36,000km of heavily populated coastlines, high risks from cyclones, and more than 200,000 hectares of coastal mangroves. We use these models to generate a dataset of several thousand simulations to describe the physical relationships between tropical cyclones, offshore wave climate, mangrove extent and geometry, and extreme water levels (i.e., flood height) along the shoreline for five storm frequency events (one storm in 5, 10, 25, 50, and 100 years) driven by local storm data.

This dataset is then used to estimate how mangroves modify extreme water levels for every kilometer of mangrove shoreline globally. Global flood depths and extents are then estimated by intersecting the global extreme water levels with a global topography dataset, at 90-meter (m) resolution, from the Shuttle Radar Topography Mission. Finally, we overlay the resulting maps of flood depths and extents on socioeconomic asset information downscaled to 90 x 90 meters. Flooded socioeconomic assets are then assessed by flood depth to identify flood damages (risk) and avoided damages (mangrove benefits).

The Averted Damages Approach provides a rigorous foundation for estimates of flood risk and habitat benefits (Barbier 2015; Beck & Lange 2016; Pascal et al. 2016; van Zanten et al. 2014). We have chosen this approach over others because it is (i) quantitative in contrast to other approaches, which use indicator (expert) scores to assess shoreline vulnerability (e.g., (Silver et al. 2019)), (ii) it uses process-based models and statistical tools to assess hydrodynamics, (iii) it uses the methods and tools of risk agencies, insurers and engineers (Narayan et al. 2016, 2017; Reguero et al. 2018), (iv) it is consistent with approaches for national accounting (Beck et al. 2016), and (v) it accurately captures impacts of extreme events.

The Averted Damages Approach aligns with the System of National Accounts (SNA) and the System of Environmental-Economic Accounting (SEEA) standards and guidelines in several ways. First, it recognizes the importance of valuing ecosystem services and natural assets within economic assessments, which is a fundamental principle of both the SNA and SEEA frameworks. By explicitly incorporating the estimation of averted damages and the value of flood protection provided by natural coastal habitats like mangroves, the approach ensures that the economic significance of these ecosystem services is properly accounted for.

Second, the Averted Damages Approach employs quantitative methods and tools that are consistent with the rigorous assessment and accounting practices recommended by the SNA and SEEA frameworks. By using process-based models and statistical tools, the approach adheres to the principles of accuracy, reliability, and transparency that are essential for economic and environmental accounting.

Furthermore, the Averted Damages Approach considers the impacts of extreme events, which aligns with the guidelines of the SEEA in assessing the economic consequences of natural disasters. By capturing the potential damages and costs that would occur in the absence of natural coastal habitats, the approach provides a comprehensive evaluation of the risk reduction and resilience-building benefits associated with these habitats.

By ensuring consistency with SNA and SEEA standards and guidelines, the Averted Damages Approach facilitates the integration of its findings into broader economic accounts and decision-making processes. The approach provides a robust and credible framework for valuing the ecosystem services and benefits provided by natural coastal habitats, thereby contributing to a more comprehensive understanding of their economic significance, and supporting informed policy and management decisions at the intersection of economics and the environment.

**FIGURE 2.1:** KEY STEPS AND DATA FOR ESTIMATING THE FLOOD PROTECTION BENEFITS PROVIDED BY MANGROVES

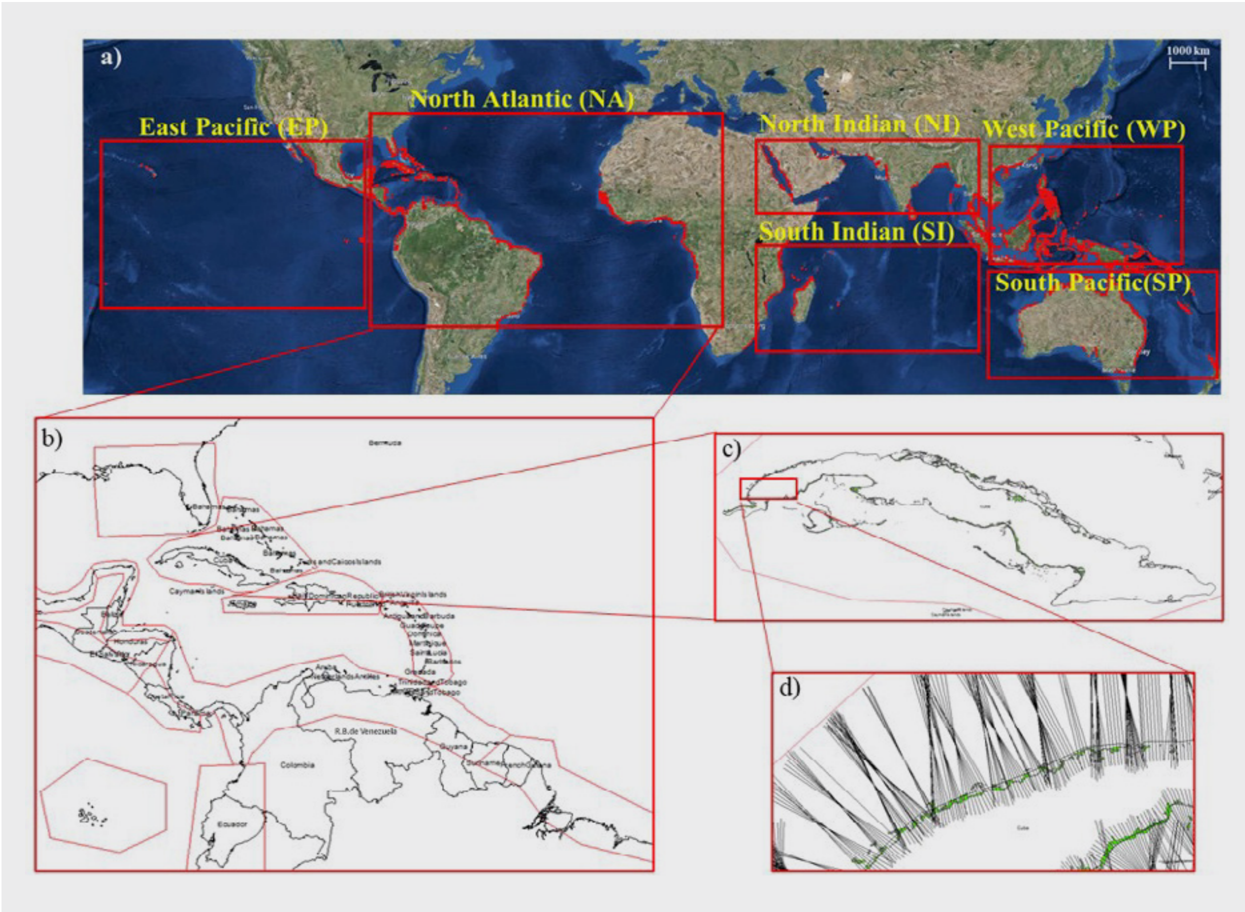

*Note: Step 1, Offshore Dynamics: Oceanographic data are combined to assess offshore sea states. Step 2, Nearshore Dynamics: Waves are modified by nearshore hydrodynamics. Step 3, Habitat: Effects of mangroves on wave run-up are estimated. Step 4, Impacts: Flood heights are extended inland along profiles (every 1km) for 1 in 5, 10, 25, 50, and 100-year events with and without mangroves. Step 5, Consequences: The land, people, and built capital damaged under the flooded areas are estimated.*

*Source: Beck et al. 2019.*

## 2.2 STUDY DOMAIN DESCRIPTION

This global study covers 700,000km of mangrove coastlines. For computational purposes, we divided the global domain into three levels (Figure 2.2). The first level is the division into six macro-regions, corresponding to the five ocean basins of tropical cyclone generation (Knapp et al., 2010): East Pacific, North Atlantic, North Indian, South Indian, West Pacific and South Pacific (Figure 2.2a). The second level divides the 700,000 km of coastline into 68 sub-regions considering coastline transects of similar coastal typology (e.g., islands and continental coasts) and similar ecosystem characteristics (Figure 2.2b). The third level is at the national scale, defining country-side units (Figure 2.2c). Within these nationwide units, we create cross-shore profiles perpendicular to the mangrove habitats for each kilometer of coastline, totaling 700,000 profiles (Figure 2.2d).

**FIGURE 2.2**: THE GEOGRAPHIC SUBDIVISIONS FOR HYDRODYNAMIC MODELS




*Note: (a) Macro-regions with the global mangrove cover in red, (b) Sub-regions in the Atlantic Ocean basin, (c) Local study units every 20km of coastline in the Northern Caribbean sub-region, (d) Profiles every 1km of coastline in the North of Cuba.*

*Source: Beck et al. 2022.*

## 2.3 THE PHILIPPINES: BASELINE CASE TO BUILD GLOBAL MODELS

The Philippines is the baseline case used to develop the global statistical models of the relationships between tropical cyclone parameters, oceanographic variables, and onshore flood extents and depths on mangrove coastlines. The Philippines is an excellent pilot case for valuation of the coastal protection ecosystem service provided by mangroves because:

- Almost 10 percent (548 events) of the global tropical cyclone records from the International Best Track Archive for Climate Stewardship (IBTrACS) database affected the Philippines (Knapp et al. 2010 and Knapp et al. 2018).
- The islands of the Philippines present high climatic variability and are at particularly high risk from natural hazards like typhoons and regular storms, which are the cause of 80 percent of the total losses from disasters (National Economic and Development Authority 2017).

- The Philippines ranks in the top 15 most mangrove habitat-rich countries, with 2,630km2 of mangroves (in 2010), representing 2 percent of the world total (Giri et al. 2011).
- These mangrove habitats show extensive variation in both cross-shore width (0.1km and 8km wide) and average depth (Menéndez et al. 2018).

By encompassing almost all possible geometries, the Philippines dataset provides a comprehensive basis for extrapolation. To account for variations in climate and coastal conditions, synthetic tropical cyclones were modeled beyond the specific climate patterns found in the Philippines. These synthetic cyclones cover a broad range of magnitudes, ensuring that the modeling approach captures the variability and potential scenarios that can be encountered in mangrove areas worldwide.

We valued the flood protection service of mangroves in the Philippines by using the numerical model Delft3D, considering both cyclonic and non-cyclonic storm conditions, for scenarios with and without mangroves. We used these results to build two global statistical models. The first, a "Cyclone Model", was developed to describe specific offshore and nearshore ocean dynamics produced by tropical cyclones (wave height, peak period, storm surge, and storm duration), and the second, a "Mangroves & Flood Height Model", estimated how the presence and profile of mangrove habitats influences the total water level during storm conditions on the shoreline. Further details about the Philippines-based models can be found in Menéndez et al. (2018, 2020) and the two models are summarized below.

## Cyclone Model: Offshore and nearshore dynamics generated by tropical cyclones

Offshore waves and storm surge generated by tropical cyclones were numerically simulated in the Philippines by using Delft3D modules "Flow" ("Delft3D-FLOW User Manual" 2006) and "Wave" ("Delft3D-WAVE User Manual" 2000). Both modules were run simultaneously in a two-dimensional grid of 5km cell-size with a time step of 30s, forced with hourly wind data and sea level pressure fields in a model that considers the non-linear interaction processes of tide, wind setup, inverse barometers, and wave setup. The model was validated by comparing the storm surge generated by typhoon Rammasun in the bays of Legaspi and Subic. We used tidal gauge data from the Global Sea Level Observing System (GLOSS, http://www.gloss-sealevel.org) for validation.

Using the results of the numerical simulations carried out with the Delft3D model in the Philippines we looked for statistical relationships between cyclone parameters and oceanographic variables to create a new predictive model, where the key oceanographic variables that affect on-shore flooding (wave height, wave period, storm tide and duration of the storm peak) were predicted based on cyclone parameters (distance, wind speed, track velocity, wind angle of incidence). In the Philippines, we simulated 548 storm events creating a database of 58 million results. We randomly selected 90 percent of the generated results to build our predictive model and used the other 10 percent for validating the predictive models. We examined the correlation between the physical tropical cyclone parameters and the oceanographic variables for two coastal area typologies: areas directly exposed to tropical cyclones and areas protected from the direct impact of tropical cyclones. Based on these variables, we then developed a best fit regression model to predict the oceanographic variables.

### Mangroves & Flood Height Model: The role of coastal habitats in nearshore dynamics

The Mangroves & Flood Height Model predicts the effects of mangrove forest characteristics on flood heights at the shoreline. Coastal vegetation provides resistance to the energy and flow of waves and water as they come onshore, which is modeled by using a friction factor based on the Manning coefficient (n). We assigned different friction factors to sandy soil (n=0.02), mangroves (n=0.14), and coral reefs (n=0.05) (Prager 1991; Zhang et al. 2012).[2] One-dimensional numerical propagations, on cross-shore profiles perpendicular to the mangrove shoreline, were carried out using the Delft3D model to obtain flood heights along the coast. We used these numerical results to create two interpolation tables for cyclonic and non-cyclonic storm conditions that correlate the oceanographic information at the seaward side of the profile (wave height, wave period, weather storm tide, and storm peak duration) and the characteristics of the mangrove profiles (width and slope) with the flood height. These tables contain 37,500 tropical cyclone simulations (50 cyclones x 750 profiles) and 90,000 non-cyclonic climate simulations (120 sea states x 750 profiles).

## 2.4 METHODS IN DETAIL

**Stage 1: Offshore tropical cyclone and non-cyclonic climate sea states**. The offshore hydrodynamic conditions (wave height, wave period, storm surge, and astronomical tide) were subdivided into two groups: (1) those produced by less intense local climate or extreme climate generated far away from the study area (regular climate or non-cyclonic conditions) and (2) those produced by local extreme events (tropical cyclones or cyclonic conditions).

<u>1A. Non-cyclonic climate:</u> Deep water ocean dynamics produced by any climate condition other than tropical cyclones was analyzed as non-cyclonic climate. Non-cyclonic climate was defined by different datasets within the period 1979 to 2010: a global wave reanalysis (Reguero et al. 2012; Perez et al. 2017), a global storm surge reanalysis (Cid et al. 2017), astronomical tide (Pawlowicz et al. 2002; Egbert & Erofeeva 2002), and mean sea level compiled from historical numerical reconstruction and satellite altimetry (Church et al. 2004). Waves and sea level conditions due to tropical cyclones were excluded and studied separately to avoid double counting, resulting, finally, in 32 years' time series of only non-cyclonic climate. The 32-year long time series of wave data (1979 to 2010) included 280,000 sea states (one sea state represents one hour of wave height, peak period, and total water level). We reduced the number of sea-state propagations by considering only the 3,787 non-repeated combinations of wave height, peak period, and total water level and, then, applying the Maximum Dissimilarity Algorithm to identify 120 sea states to be propagated with the Snell law and shoaling equation across coastal profiles. All of the models and data in the non-cyclonic climate analysis, including waves and storm surge, have been globally validated (e.g., Reguero et al. 2012; Perez et al. 2017; Cid et al. 2017). The non-cyclonic climate analysis

2 Data for the three bottom types was used, but the only with/without scenario comparison was done with the mangroves.

covers most of the storm and flood risk conditions globally (including tropical depressions and storms) except for cyclone conditions, which represent comparatively small (spatio-temporally) but locally intense conditions.

1B. Tropical cyclones: Tropical cyclones were considered separately from non-cyclonic climate if the 10-minute sustained wind speeds (W10m) exceed 118km/h. Tropical depressions (W10m ≤ 62km/h) and tropical storms (63km/h ≤ W10m ≤ 118km/h) are included in the non-cyclonic climate models. For historical tropical cyclones, we use the IBTrACS database (Knapp et al. 2018), which provides six-hourly data for wind speed, atmospheric pressure, and track position, and contains regularly updated storm data (https://www.ncdc.noaa.gov/ibtracs/).

**Stage 2: From offshore dynamics to shallow water.** We obtained ocean hydrodynamics on the seaward side of each cross-shore profile cyclonic and non-cyclonic conditions. Waves interact with the bottom and other obstacles (e.g., islands) as they approach the coast and modify height and direction through shoaling, refraction, diffraction, and breaking processes.

2A. Non-cyclonic climate: For non-cyclonic climate, several thousand offshore ocean parameters representing non-extreme sea states are clustered into 120 representative sea states using a Maximum Dissimilarity Algorithm (Camus et al. 2011a; Camus et al. 2011b). Wave and water level conditions at the seaward point of each profile are then associated with the nearest non-cyclonic climate sea state. From this, a regression model was created that equates offshore non-cyclonic climate sea states with wave and water level conditions at the seaward end of a profile.

2B. Tropical cyclones: We used the Cyclone Model described above to estimate key nearshore parameters from cyclones including wave height (Hs), peak period (Tp), storm surge (SS) and the time duration of the meteorological tide (Tss).

**Stage 3: Modeling the role of coastal habitats in nearshore dynamics, flood height.** We used the Mangroves & Flood Height Model (described above) to estimate flood height given mangrove length and depth, significant wave height, peak period, and total water level at the head of each cross-shore profile. After calculating the historical time series of flood height (1979 to 2010), we applied an extreme value analysis to obtain 1 in 5-, 10-, 25-, 50-, and 100-year extreme sea levels at the coast. To do that, we selected maximum values over a threshold (minimum 1 event every 5 years) and then adjusted these values to a Generalized Pareto-Poisson distribution. One-dimensional wave and surge propagation model through the cross-shore profiles is commonly used even in site-based models (Beck et al. 2018). The consideration of non-linear effects is only possible using computationally expensive phase resolving models (e.g., XBeach) at local scales (e.g., bays). This modeling approach is not feasible at the global scale because of computational capacity and the lack of high-resolution bathymetric data, and especially if risk is to be evaluated probabilistically across multiple events and scenarios (Beck et al. 2018).

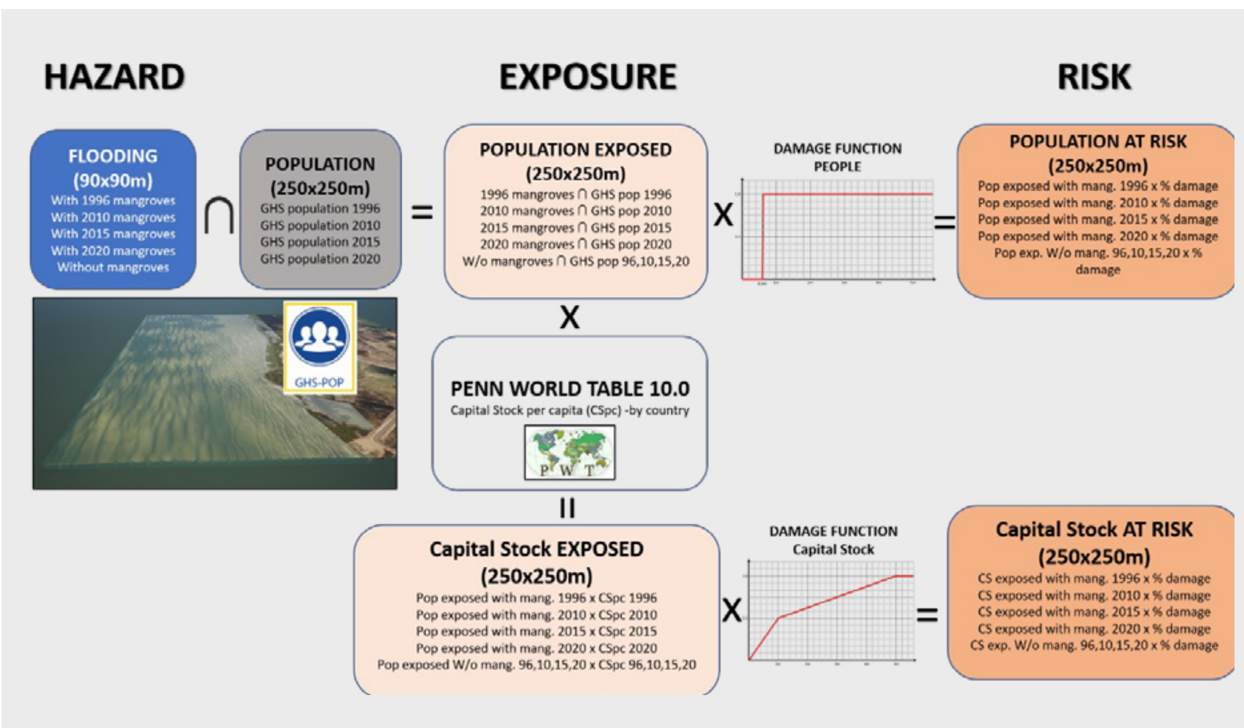
**Stage 4: Calculating impacts: Flooding maps.** To estimate flooding, we used a modified bathtub flooding model, which includes a hydraulic connectivity requirement for flooding connected points across the coastal topography. We used 1 in- 5-, 10-, 25-, 50- and 100-year flood heights every 1km of coastline, a global topography dataset,

20 Desalination is recorded as the abstraction of saltwater.

at 90m horizontal resolution, from the Shuttle Radar Topography Mission (Farr et al. 2007) and a bathtub method for flooding based on hydraulic connectivity between pixels. The final product of this stage were 50 global flood maps representing 5 return periods (1 in 5-, 10-, 25-, 50- and 100-year events), 2 storm conditions (cyclonic and non-cyclonic), and 5 mangrove extents (1996, 2010, 2015, 2020, and no mangroves).

**Stage 5: Assessing global flood consequences in areas protected by mangroves.** The expected flood risk and benefits provided by mangroves were presented in social and economic terms. In this step, we calculated the effects of flooding in terms of (1) people exposed, (2) capital stock exposed, (3) people at evacuation risk, and (4) losses of capital stock. We intersected the flood maps with population data from the new Global Human Settlement population grid (GHS-POP) released in 2022. The dataset is a spatial population raster that depicts the distribution of residential population, expressed as the number of people per cell ([https://ghsl.jrc.ec.europa.eu/ghs_pop2022.php](https://ghsl.jrc.ec.europa.eu/ghs_pop2022.php)) and capital stock data from the PWT version 10.0 ([https://www.rug.nl/ggdc/productivity/pwt/](https://www.rug.nl/ggdc/productivity/pwt/)). The workflow of the exposure and risk assessment methodology is summarized in Figure 2.3.

**FIGURE 2.3**: CWON RISK ASSESSMENT METHODOLOGY



We followed a multi-step approach to obtain people and capital stock exposure and risk:

**Step 1. Global population and capital stock distribution:** Population distribution and density is obtained from the spatial raster GHS-POP R2022A. This dataset contains global residential population estimates at 1km resolution for 1975, 1990, 2000, 2015, and 2020. We downscaled the population rasters from 1km to 250m resolution in order to match the past GHS-POP R2019, which are available for the years 1975, 1990, 2000, and 2015 at 250m.

To obtain population estimates for the years 1996 and 2010 in our analyses, we interpolated the global data between 1990 to 2000 and 2000 to 2015, respectively. Then we calibrate both, 1996 and 2010 interpolated grids, with nationwide population statistics from the World Bank (World Bank Data). The calibration consists of adjusting the total people per country from the interpolated grids to the World Bank data. In the case of 2020, we had to reduce the population raster from 1km to 250m by equally distributing people across each 250x250m pixel, but no further adjustments were needed.

Global capital stock was calculated using PWT 10.0. This table provides information on relative levels of income, output, input, and productivity. It includes 182 countries and covers 70 years (1950 to 2019).

For our economic analyses we used the national data of capital stock ("rnna" variable) at constant 2017 national prices and transformed these into constant 2020 national prices by using country-based consumer price index data from the World Bank (https://data.worldbank.org/indicator/FP.CPI.TOTL). To derive a comprehensive understanding of the global capital stock distribution, our methodology involved several steps. Initially, we computed the capital stock per capita for each country. This step allowed us to determine the amount of capital assets available on a per-person basis in each nation. Subsequently, we integrated this country-level information with our previously calculated data, which specified the population residing within each 250x250m grid cell across the globe. By doing so, we could gauge the total capital stock associated with each grid cell, considering the population it encompasses. To create a comprehensive and highly detailed global capital stock distribution map, we applied these calculations at a fine-grained resolution of 250m. The result is a raster representation that provides an in-depth view of how capital assets are distributed across the world at this level of granularity.

**Step 2. Resampling coastal flooding grids (at 90m) to population and capital stock resolution (250m):** To overlay flood and assets maps, both must be at the same horizontal resolution. We upscaled the flood rasters from 90m to 250m to be consistent with the resolution of the global population and asset data. We use the ArcGIS toolbox function, "resample", for the spatial redistribution of the flooding grids. Three main reasons support this approach: (1) By upscaling flood risk to 250m we are still working with sufficiently high-resolution spatial risk to aggregate results at both national level and at any local level higher resolution; (2) working with 250m global rasters rather than 90m reduces the size of the intermediate files and therefore the computational demand of the overlying process; and (3) we do not need to re-calibrate the new rescaled rasters by adjusting the total population and total capital stock per country at 90m resolution to those at 250m.

**Step 3. Exposure. People and stock in flooded areas:** Here we calculate the number of people and then the capital stock exposed to coastal flooding in 1996, 2010, 2015, and 2020 with and without mangroves. We first reclassify the flooding raster into 1 and 0 values.

We assign 1 to flooded pixels with water, and 0 to dry pixels. Then we multiply population rasters by the reclassified flood raster and obtain the global distribution of people exposed to coastal flooding. The capital stock exposed to flooding is then calculated by multiplying people exposed by capital stock per capita at national level (PWT 10.0). The exposure layers will inform how many people and assets are in flooding areas, but not the real damage to people and the real economic loss (risk). Calculating flood risk requires that we estimate flood damages using damage functions, which relate flood damages at a location to the flood depth at that location.

**Step 4. Damage coefficients:** Flood damage depends on the water depth and the type of asset. We use different damage functions for population and capital stock. For people, the damage function assumes that, in a grid cell, people are not affected by water below 30cm in depth and all people are affected by flood water depths greater than 30cm. This a commonly used threshold in civil protection services to decide when people must be evacuated (Shao et al. 2015).

For capital stock, we combined data from JRC (Huizinga et al. 2017) and Hazus (Scawthorn et al. 2006) flood depth damage curves. The best combination of these curves globally results in a damage function that ramps up linearly from 0 to 50 percent of damage when water depth is below 1m. Then damage increases at a slower rate from 50 percent at 1m water depth to 100 percent at 5m. We use these curves to calculate a global raster of damage coefficients to people and capital stock. In prior work, we tested the use of various damage curves (including complex damage functions) for population, residential, and industrial stock from Hazus in the Philippines (Menendez et al. 2018), and we found that the results were not significantly different from approaches using simpler curves such as those in Figure 3.2.

**Step 5. Risk. People evacuated and capital stock loss due to coastal flooding:** To calculate risk, we multiply damage coefficient rasters by people and capital stock exposure rasters. A total of 160 risk maps for the different conditions and scenarios are generated as a combination of asset type (x2), year (x4), storm condition (x2), ecosystem presence (x2), and return period (x5) (see **Table 2.1**).

**Step 6. Nationwide aggregation results:** Risk to people and capital stock is aggregated at national scale. We first create a 10km external buffer for each country and find the pixels that lay into each country buffer boundary. We calculate the total number of people and the total capital stock value of each country under each scenario.

**Step 7. Annual expected risk and benefits:** In addition to assessing risk for specific events (such as a 100-year storm event), we also examined average annual expected damages and benefits provided by mangroves. To estimate annual risk, we integrated the values under the extreme value distribution curves that compare capital stock damaged, or people affected, by storm return period—in other words, the integration of the expected damage with the probability of the storm events.

**Step 8. 100-year asset value calculation:** We calculated the present value of mangrove benefits over a period of 100 years. We assumed a constant benefit flow and 4 percent discount rate to obtain the 100-year asset value (Eq. 2).

$$PV = \sum_{i=1}^{i=100} \frac{AEB}{(1+r)^{i}} \qquad (2)$$

Where *PV* is the present value, AEB are the annual expected benefits, *r* is the discount rate (4%) and "*i*" is each year within the life cycle period (i=1-100 years).

**TABLE 2.1**: RISK MAPS SUMMARY TABLE

| YEARS | ASSETS | MANGROVE SCENARIO | STORM CONDITION | RETURN PERIOD |
|---|---|---|---|---|
| 1996 | People | With mangroves | Cyclonic (tropical cyclones) | 1 in 5 years |
| 2010 | Capital stock | Without mangroves | Non-cyclonic (regular climate) | 1 in 10 years |
| 2015 | | | | 1 in 25 years |
| 2020 | | | | 1 in 50 years |
| | | | | 1 in 100 years |

## 2.5 MODEL LIMITATIONS AND ASSUMPTIONS

Our efforts represent state of the art process-based assessments of flood risk and mangrove benefits globally. For most countries with mangroves, these represent the best data and models for mangrove benefits, and for many of these countries the best national-level estimate of flood risk. For this global study, we have developed a dataset of several thousand simulations to describe how mangroves modify extreme water levels at the shoreline, for every kilometer of mangrove coastline in the world. This approach is highly efficient and allows us to estimate coastal flood risk globally for new scenarios of mangrove presence and extent.

As with all global models, there is the potential that individual countries may have better data, for example, on mangrove habitats or bathymetry (measuring the depth of water), which could be used for higher resolution analyses of risks and benefits. For mangrove coverage, we have only the extent of mangroves, for example, not the age, structure, density, species, degree of degradation, and other factors that can affect the capacity of mangroves to reduce flooding. We use mangrove length and water depth (or elevation) across each 1km cross-shore profile as input to the model.

The greatest sources of uncertainty in coastal flood risk modeling are estimates of topography and bathymetry. Given that flooding and damage from tropical storms are among the greatest risks to people and property, better elevation and depth data is urgently needed. Fortunately, in the past decade there has been a substantial increase in the availability of high-resolution coastal elevation data through the widespread use of LIDAR (light detection and ranging). Nearshore bathymetry, however, remains a major gap, though there are advances in remote sensing that could help.

Other sources of uncertainty rely on socioeconomic estimates. The changes in flood risk due to changes in the socioeconomics are more than twofold greater than the sensitivity to changes in the hydrodynamic conditions.

Our coastal flooding analyses have several significant, combined improvements over other recent global flooding analyses including:

- Generation of global flood maps at 90m resolution.
- Consideration of hydraulic connectivity in the flooding of land.
- The use of 30 years of wave, surge, tide, and sea level data.

- Reconstruction of the flooding height time series and associated flood return periods.

Our global flood risk models also include the latest datasets released of mangroves, population distribution, and economics. Remaining constraints for this global coastal flooding model include the consideration of flooding as a one-dimensional process and the difficulty in representing flooding well in smaller islands.[3]

In the previous analysis (CWON 2021, Beck et al. 2022b), we modeled 111 countries with mangroves and only 92 benefited from mangroves. In this new updated analysis, we modeled 121 countries with mangroves and 97 countries benefited from mangroves. More details about the selection of countries providing mangrove benefits are presented in Appendix 1.

We do not account for changes in sea level from 1996 to 2020; these effects would be small over this time period and would have minor impacts on flooding. We also calculate the (local) distributions of extreme sea levels across this entire time period. The statistical distributions representing extreme sea levels were kept unchanged throughout the entire time period under consideration. Keeping the extreme sea levels distribution constant simplifies the analysis by assuming homoscedasticity (variability remains constant over time). This simplification can be helpful for certain analytical purposes, especially when you want to focus on other variables or factors without the added complexity of modeling changing variances. This is the case of this analysis, where we focus on modeling the effect of changes in mangrove distribution.

We are assuming that the 30-year historical data of waves and cyclones is applicable to 1996, 2010, 2015, and 2020. Adjustments within the time period would drastically shorten the data record, which is not a standard approach for risk and flood modeling.

**Caveats in the interpretation if the data is used at a subnational scale:**

- Data availability and accessibility: Working with high-resolution data at a global scale can be challenging because it is based on other spatial explicit data that is at a coarse scale (e.g., population data at 1km resolution or economic data at national scale resolution), which can introduce uncertainties and gaps in the analysis.
- Data accuracy and precision: While high-resolution data provides more detailed spatial information, it is essential to assess the accuracy and precision of the data. The quality and reliability of the input data, including elevation models and socioeconomic data, can influence the accuracy of the flood risk assessment.
- Validation challenges: Validating high-resolution global data presents significant challenges due to the lack of comprehensive ground truth data at such a fine-grained resolution for the entire globe. The availability of local validation data, such as historical flood records or detailed flood damage assessments, is often limited or inconsistent across different regions. This makes it challenging to validate and verify the accuracy of the high-resolution global flood risk model. As a result, there may be uncertainties in the model's performance and limitations in assessing its reliability for specific locations or subnational areas. Rigorous validation efforts, where possible, should be conducted to assess the model's performance and ensure its suitability for subnational applications.

3 The challenges encountered in modeling are primarily attributed to the intricate nature of building a one-dimensional model for regions characterized by very small islands and highly fragmented coastlines. The resolution of the model is not the limiting factor; rather, it is the complex and geographically dispersed nature of the coastal features that pose significant difficulties in the modeling process.

# 3 Datasets

## 3.1 OVERVIEW

The dataset overview section provides a comprehensive view of the various datasets used in this study to assess coastal flood risk and the associated impacts. This section begins with a detailed table listing all the datasets employed (Table 3.1), followed by a thorough explanation of key datasets that play a crucial role in the analysis. The datasets discussed include mangrove data, population data, capital stock, consumer price index, and damage functions. Each dataset contributes essential information to our understanding of coastal vulnerability and the estimation of potential damages. By presenting these datasets and their significance, we aim to provide a transparent and comprehensive account of the data sources used in this assessment.

Several databases used in the assessment of mangrove coastal protection benefits have been updated and improved since the CWON 2021 report (World Bank 2021), in particular the mangrove cover maps and socioeconomic data. Due to these changes, the results corresponding to the previous analysis (1996 to 2015) were updated, and they changed quantitatively (slightly) but not qualitatively. The main changes in the underlying datasets are explained.

**TABLE 3.1**: LIST OF DATASETS USED IN THE ANALYSIS

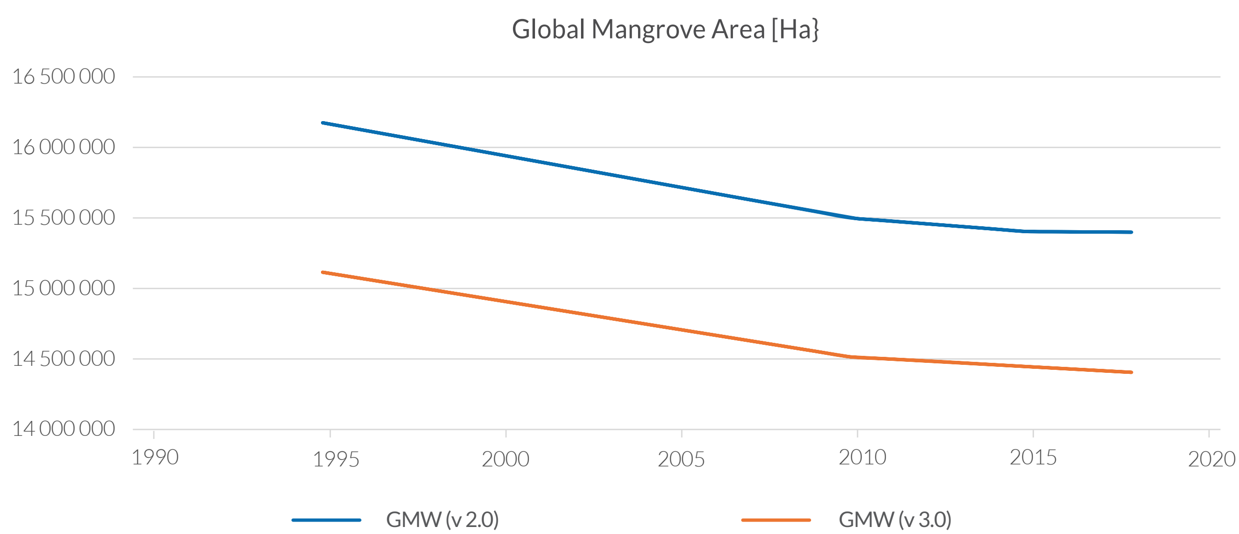
| DATABASE | DATABASE NAME | INSTITUTION | VARIABLE | SPATIAL DOMAIN AND RESOLUTION | TEMPORAL DOMAIN AND RESOLUTION | WEB LINK |
|---|---|---|---|---|---|---|
| Tropical cyclones | IBTRrACS | NOAA | Wind speed Long, lat, time | Global (10 km) | 1841-2023 (3 hours) | IBTrACS |
| Waves | GOW 2.0 | IH Cantabria | Hs, Tp, Dm | Global (250km) | 1979-2010 (1 hour) | GOW 2.0 |
| Astronomical tide | GOT | IH Cantabria | Astronomical tide elevation | Global (4km coast, 18km open ocean) | Any (1 hour) | GOT |
| Storm surge | Extension of DAC | IH Cantabria | Storm surge level | Global (200km) | 1871-2010 (6 hours) | Storm Surge |

| DATABASE | DATABASE NAME | INSTITUTION | VARIABLE | SPATIAL DOMAIN AND RESOLUTION | TEMPORAL DOMAIN AND RESOLUTION | WEB LINK |
|---|---|---|---|---|---|---|
| Mean sea level | Sea Level Rise | CSIRO Marine Research | Mean sea level | Global (100km) | 1950-2000 (1 month) | MSL |
| Bathymetry | GEBCO Allen Coral Atlas | GEBCO Allen Coral Atlas | Water depth | Global (450m) Global (10m | No | GEBCO |
| Topography | SRTM PLUS | NASA | Land elevation | Global (90m) | No | SRTM |
| Mangroves | Global Mangrove Watch 3.0 | UN-WCMC | Mangrove distribution | Global (1km) | 1996-2020 (annual) | GMW 3.0 |
| Population | GHS-POP – R2022A | European Commission | # of people | Global (250m and 1km) | 1975-2020 (annual) | GHS-POP |
| Capital stock | Penn World Table 10.0 | The World Bank | Capital stock at constant 2017 national prices | Global (country) | 1950-2019 (annual) | PWT 10.0 |
| Consumer price index | CPI | The World Bank | Consumer price index | Global (country) | 1960-2021 (annual) | CPI |
| Damage function people | People damage curve | Self-produced | % damage to people | Global | No | People evacuation standard |
| Damage function stock | Capital stock damage curve | Self-produced from: Fema-Hazus JRC-European Commission | % damage to capital stock | Global | No | FEMA-Hazus JRC |

## 3.2 MANGROVE DATA

Global Mangrove Watch (GMW) released an updated version (GMW 3.0) of global mangrove coverage in August 2022 (Bunting et al. 2022). This release includes new mangrove distribution maps corresponding to the 2016 to 2020 period and updates/improvements of the historical mangrove distribution data for the period 1996 to 2015. In CWON 2021, we used GMW 2.0 for the time periods 1996, 2010, and 2015. In this new report we used GMW 3.0 to update 1996 to 2015 mangrove coverage and added a new time point corresponding to 2020. The most significant difference in these datasets is that the improved GMW 3.0 shows a consistently greater global coverage than GMW 2.0 (about 7 percent greater, see Figure 3.1). To consistently assess mangrove benefits over time, all data (not just 2020) were updated, the flood models were re-run, and new assessments of risk and benefits were developed.

**FIGURE 3.1**: DIFFERENCES IN GLOBAL MANGROVE COVER BETWEEN GMW 2.0 AND GMW 3.0




Despite observing changes in the total area of mangroves, we discovered that these alterations had minimal impact on the results. This is due to the fact that the crucial factor driving variations in coastal flooding, which is the cross-shore width of the mangrove forest, remained relatively stable or exhibited minimal change in the new data. It is important to emphasize that modifications in the overall area of mangroves do not necessarily correspond to changes in flood risk, as the effectiveness of mangroves' protection services is primarily influenced by the cross-shore width, which exhibited limited variation.

The GMW has generated a global baseline map of mangroves for 2010 using ALOS PALSAR and Landsat (optical) data, and changes from this baseline for seven epochs between 1996 and 2020 derived from JERS-1 SAR, ALOS PALSAR, and ALOS-2 PALSAR-2. Annual maps are planned from 2018 and onwards. The primary objective of the GMW has been to provide countries with mangrove extent and change maps to help safeguard against further mangrove forest loss and degradation. The GMW aims to provide geospatial information about mangrove extent and changes to the Ramsar Convention, national wetland practitioners, decision-makers, and nongovernmental organizations.

## 3.3 POPULATION DATA

Global exposure data for people was obtained from GHS-POP grid dataset from the European Commission (https://ghsl.jrc.ec.europa.eu/ghs_pop2022.php).[4] This new package, released in 2022 (GHS R2022A, (Schiavina et al. 2022)) substitutes the previous version (GHS R2019) and provides estimates of global populations and their distribution for 1975, 1990, 2000, 2015, and 2020, as well as future projections to 2025 and 2030. GHS R2022A matches or outperforms other data sources for accuracy in epochs 2018 and 2020 and matches or outperforms also all the other single epochs (1975, 1990, 2000, and 2015) included in the previous release GHS R2019. The global distribution of population used for 1996, 2010, and 2015 is 250m resolution (GHS R2019), while 2020 population distribution released in 2022 (GHS R2022A) with the new version is at 1km resolution.

## 3.4 CAPITAL STOCK DATA

This study uses data from PWT 10.0 from the Groningen Growth and Development Center (https://www.rug.nl/ggdc/productivity/pwt/). This version is a database with information on relative levels of income, output, input, and productivity. The table covers 182 countries and 70 years (1950–2019). We used the nationwide data of capital stock at constant 2017 national prices and transformed these into constant 2020 national prices by using country-based consumer price index. Then, we calculated the stock per capita at each country and multiplied these national values by the population located at each grid cell. We then obtained the global stock distribution at 250m resolution. There were 22 tropical nations that had mangroves but were not included in the PWT; we filled most of these gaps with national data from the World Bank. There were a few remaining countries and territories that we were not able to include in the analyses due to the lack of economic data, including Eritrea, French Guiana, New Caledonia, Micronesia, Palau, Somalia, Guadeloupe, Martinique, Timor Lester, Mayotte, Samoa, US Virgin Islands, Saint Martin, and American Samoa.

The new updated version of the PWT (10.0, Feenstra et al. 2015) was released in June 2021. We used the capital stock at constant national prices ("rnna") and total population ("pop") to calculate the gross domestic product (GDP) per capita ratio at national level. Several changes have been introduced in the most recent version of PWT 10.0 relative to the version used in the previous CWON report (PWT 9.1). These differences result in changes in the economic valuation of mangroves worldwide. The main updates are described below:

- Capital stock in PWT 9.1 was in constant 2011 national prices, while capital stock in PWT 10.0 is in constant 2017 national prices.
- In PWT 9.1, the time series was 1950 to 2017. PWT 10.0 covers the period 1950 to 2019.
- Capital stock was recalculated in some countries (e.g. China, Sudan) using an outdated nominal value for GDP. Capital stock values are remarkably higher than previously estimated in some countries.

4 The Global Urban Footprint primarily focuses on urban areas and their extent, which may not accurately capture the distribution and density of human settlements in coastal regions. The Global Human Settlement dataset, on the other hand, provides more comprehensive coverage of human settlements, including both urban and rural areas. When assessing the impact of coastal storms, it is essential to consider not only the built environment but also the vulnerability and exposure of the population. The Global Human Settlement dataset incorporates population distribution and density, allowing for a more accurate estimation of the number of people at risk from coastal flooding.

## 3.5 CONSUMER PRICE INDEX

For this new analysis, we first transformed capital stock in constant 2017 national prices to capital stock in constant 2020 national prices using the 2021 updated country-based consumer price index from the World Bank. The index is the most widely used measure of inflation and is sometimes viewed as an indicator of the effectiveness of government economic policy.

The adjustment applied in this analysis is described by the equation below.

Where V is the capital stock value in any given year's constant national price and CPI is the consumer price index.

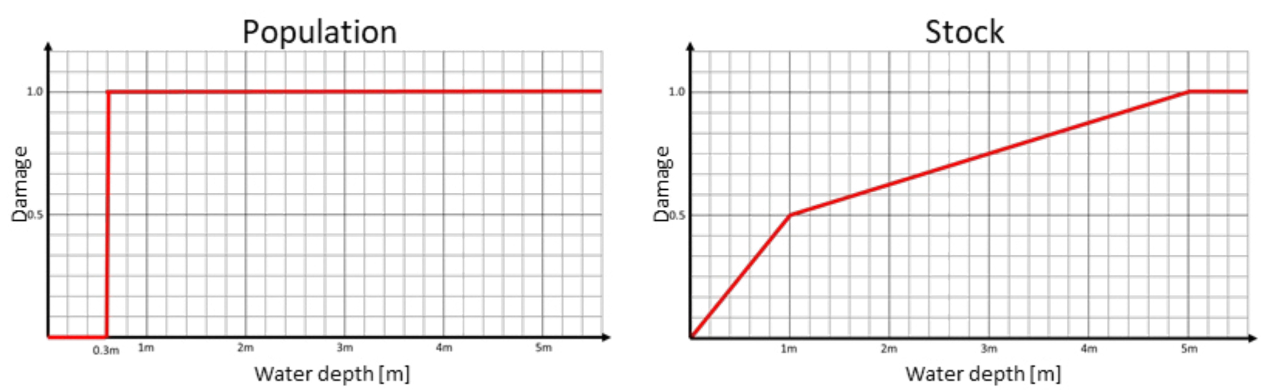
$$\frac{V_{2017}}{V_{2020}} = \frac{CPI_{2017}}{CPI_{2020}} \rightarrow V_{2020} = V_{2017} \cdot \frac{CPI_{2020}}{CPI_{2017}}$$

## 3.6 DAMAGE FUNCTIONS

Global flood depth damage functions are needed to evaluate the sensitivity of people and property damaged at different flood levels. The report from the EU Joint Research Centre (JRC) collected data from Africa, Asia, Oceania, North America, South America, and Central America and proposed damage functions for residential and industrial stock in each region (Huizinga et al. 2017). We refer to these as JRC damage functions. These damage functions are a better alternative to damage curves from FEMA Hazus (Scawthorn et al. 2006), which were based only on US collected data but were frequently extrapolated for use in other geographies. JRC damage functions aim to address flooding effects on property globally, developing a consistent database of depth-damage curves. We used both, JRC and Hazus to calculate capital stock damages (Figure 3.2). Capital stock damage results from the integration of global JRC damage functions, calibrated with Hazus damage curves for different building types.

The damage curve for people was built based on a commonly used threshold in civil protection services to decide when people must be evacuated. It indicates that no people are affected in areas with less than 30cm water depth, and 100 percent of people affected in areas with water depth above 30cm (Figure 3.2).

**FIGURE 3.2**: FLOOD DEPTH DAMAGE CURVES FOR PEOPLE AND STOCK



# 4 Results

## 4.1 MANGROVE COVER

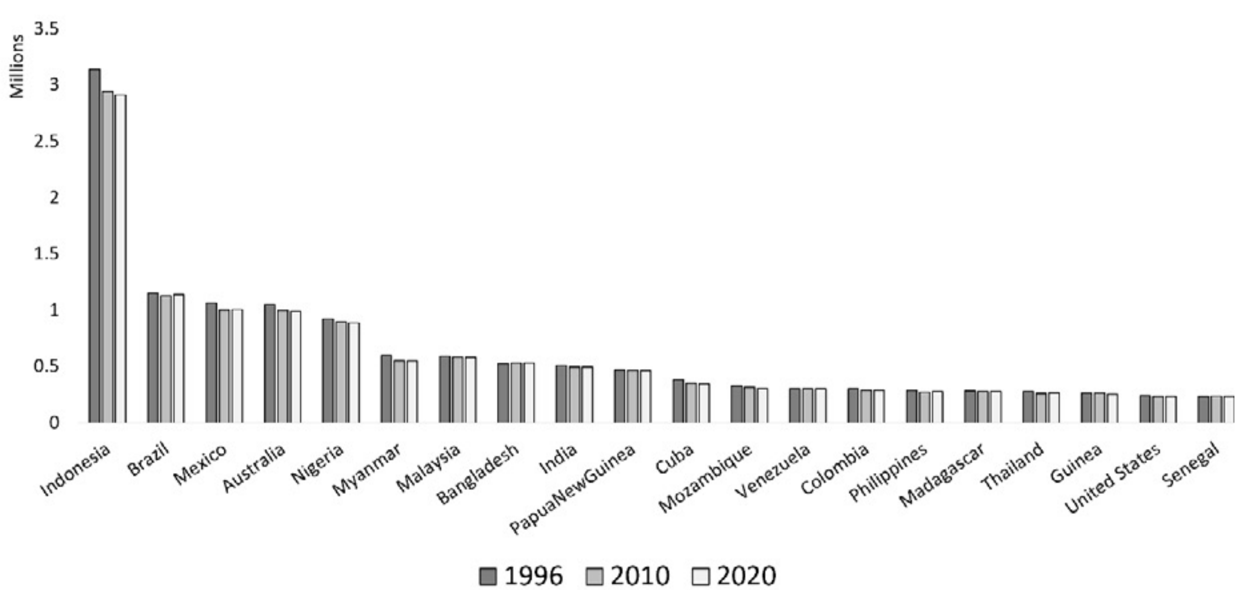
Mangrove extent declined significantly at the end of last century and the first decade of the current century. According to the GMW dataset, almost 4 percent of global mangrove cover was lost between 1996–2010, from 158,000km$^2$ to 151,000km$^2$. Countries such as Indonesia, Mexico, Australia, Myanmar, Cuba, Nigeria, Bahamas, and Brazil lost the most mangrove forest in the late 1990s and early 2000s (Figure 4.1b). In this period, a few countries saw gains in mangroves (Appendix 2, tables A4 and A6), which included countries in in Africa (Suriname, the Gambia, Guyana, Senegal, Gabon, Liberia, and Cameroon) and Central America (Nicaragua, Honduras, El Salvador, Panama, and Costa Rica).

However, from 2010 to 2020, only 0.66 percent of global mangrove cover was lost. Many countries that had previously experienced significant mangrove loss (Appendix 2, tables A5 and A7), now saw gains between 2 percent and 25 percent in mangrove area (e.g., Turks and Caicos, Oman, Djibouti, Peru, China, and Thailand). In contrast, there are still nations where mangroves experienced significantly higher losses in the last decade than within the period 1996 to 2010 (Appendix 2, tables A5 and A7): Saudi Arabia, Taiwan, Jamaica, Honduras, Nicaragua, Puerto Rico, and Costa Rica experienced an increasing mangrove loss rate between 5 percent and 25 percent.

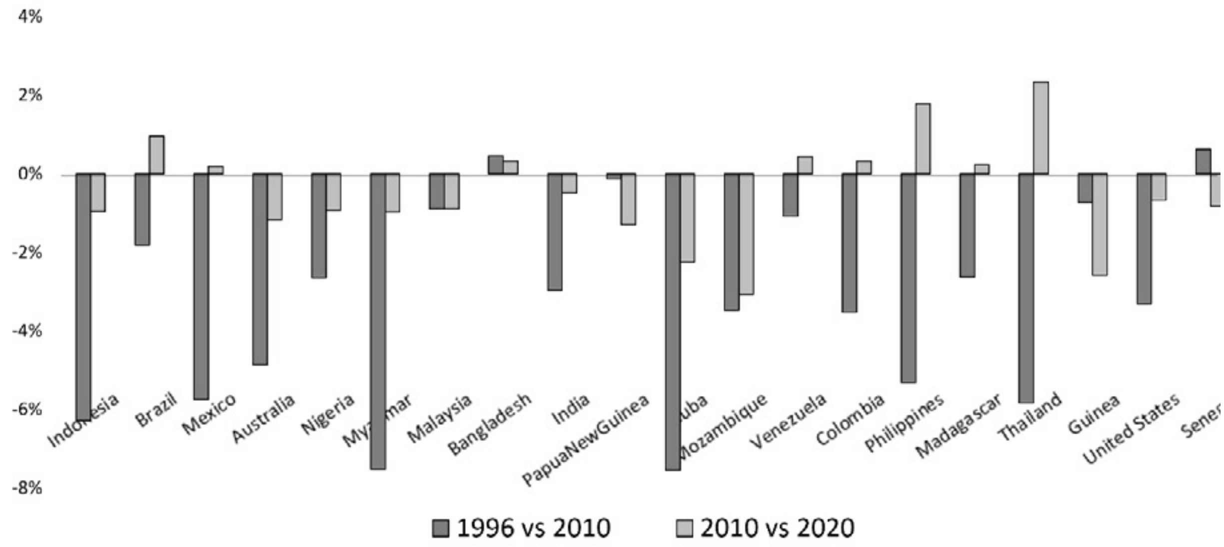
The change in the coverage of mangroves is spatially variable, which affects the protection provided by mangroves. The effect on flood height at the shore is the best way to consistently compare how mangrove loss (and gain) affects flooding.

**FIGURE 4.1**: MANGROVE AREA IN THE TOP 20 COUNTRIES WITH MORE MANGROVES IN 1996

a) Mangrove area [ha]



b) Changes in mangrove area [ha]

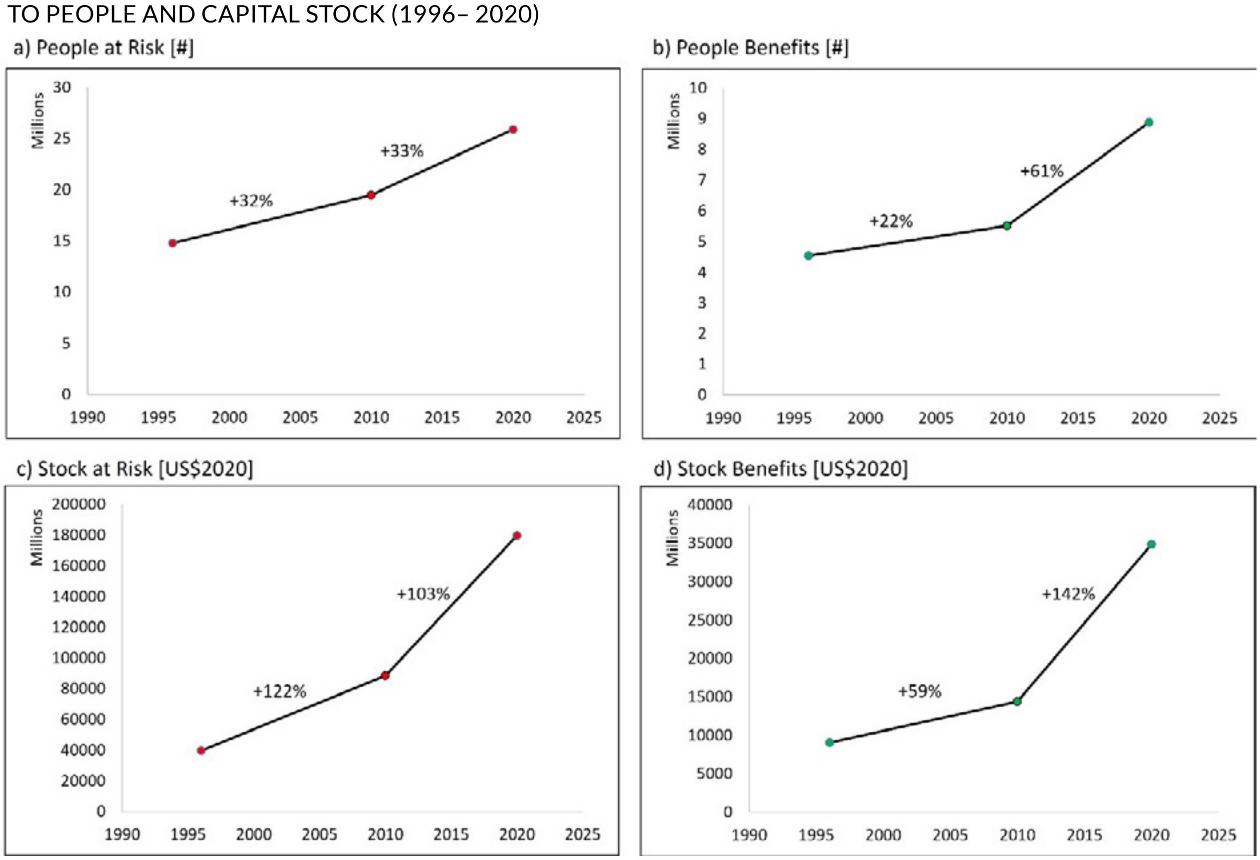



*Note: Panel (a) shows the total hectares of mangrove in 1996, 2010, and 2020. Panel b) shows the percentage change in mangrove area from two-time frames: 1996 to 2010 and 2010 to 2020 (top 20 countries with the largest mangrove cover shown).*

## 4.2 OVERALL RESULTS: FLOOD RISK AND BENEFITS

### 4.2.1 Flood Risk and Mangrove Benefits Globally Aggregated

**FIGURE 4.2**: GLOBAL FLOOD RISK AND MANGROVE FLOOD PROTECTION BENEFITS TO PEOPLE AND CAPITAL STOCK (1996– 2020)




*Note: The results are divided into two periods: 1996–2010, 2010–2020*

We observed different trends in flood risk and flood benefits across two different periods (1996 to 2010 and 2010 to 2020). From 1996 to 2010, when mangrove loss was more severe globally (about 4 percent), flood risk increased more than mangrove benefits (32–122 percent increase in risk versus a 22–59 percent increase in benefits, see Figure 4.2). In contrast, from 2010 to 2020, when mangrove loss slowed down (about 0.7 percent), flood risk increased less than mangrove benefits (33–103 percent increase in risk versus a 61–142 percent increase in benefits, see Figure 4.2). As coastal flooding increases slowed down, more people started living in mangrove-protected areas, resulting in high benefits and higher potential risks in the future if we experience similar losses to those experienced from 1996 to 2010.

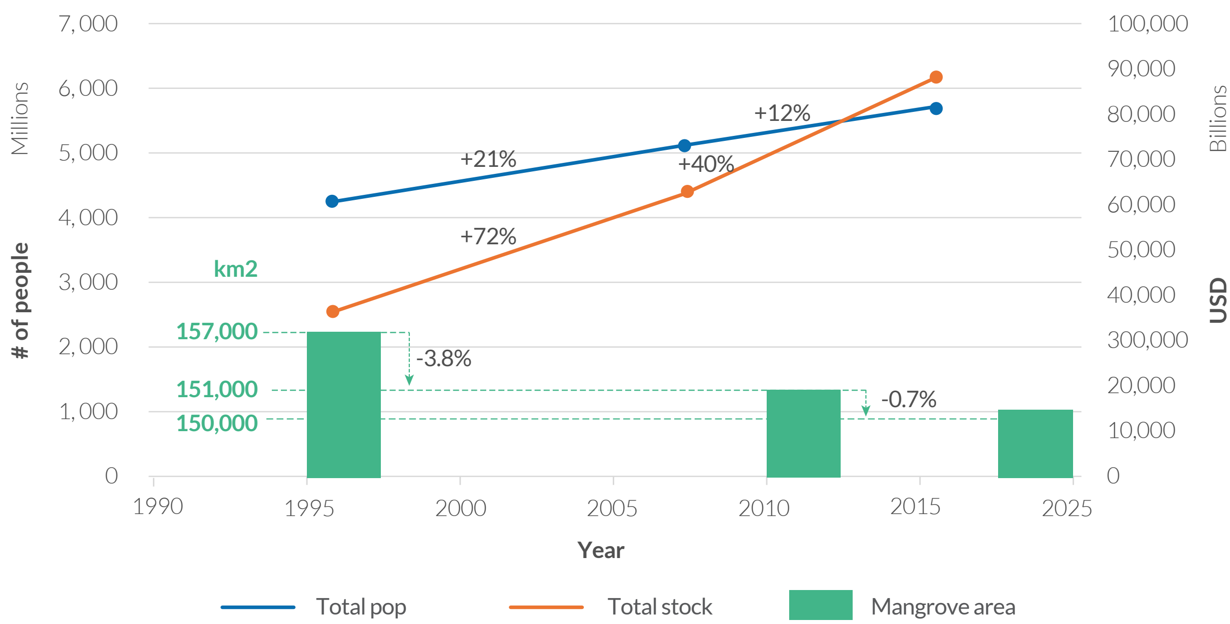
There are two reasons that explain this global pattern change:

- Flood extent in 2010 increased significantly due to the 4 percent mangrove loss, rapidly reducing the land area protected by mangroves and preventing people from settling in mangrove-protected zones.
- Flood extent did not increase significantly from 2010 to 2020, resulting in more people and economic opportunities in the mangrove-protected zones than in previous decades.

**Relative contribution of the socioeconomic development and mangrove decline in flood risk:**

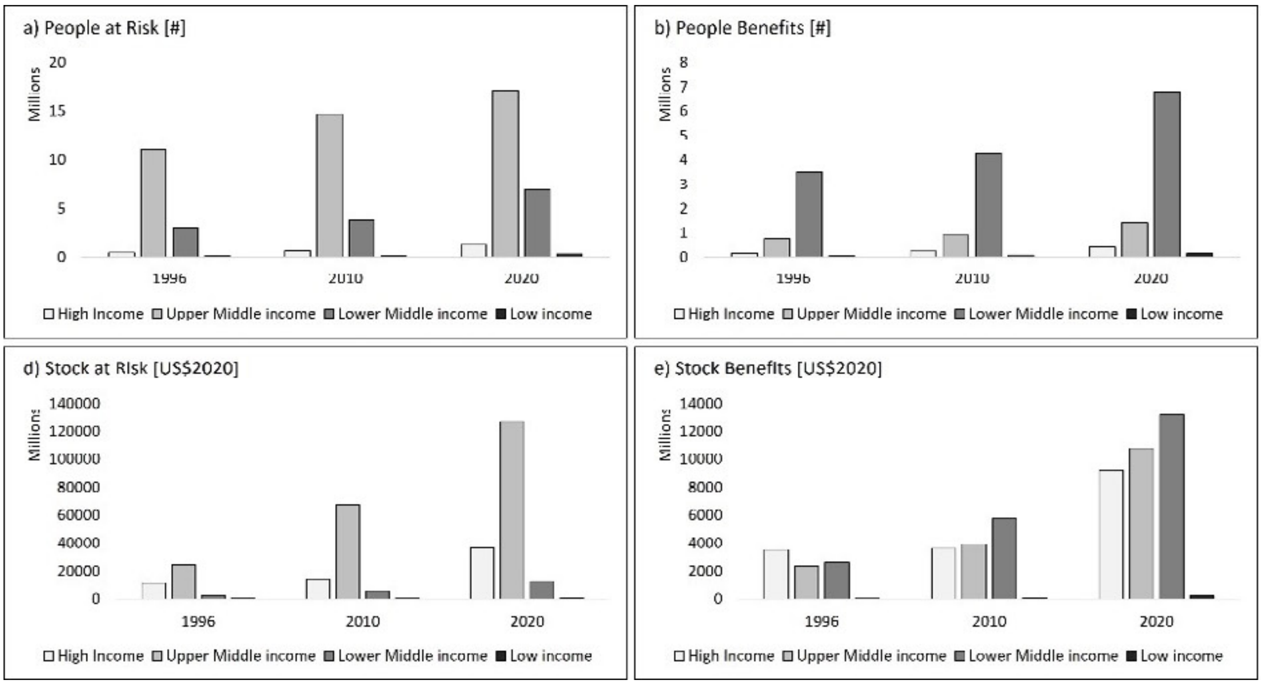
The impact of flood risk caused by a combination of economic growth and changes in mangrove forests is not straightforward. This means that we cannot simply measure how much each factor contributes to the overall increase in flood risk. For example, between 1996 and 2010, there was a 3.8 percent reduction in mangrove cover, a 21 percent increase in population, and a 72 percent rise in capital stock (Figure 4.3). These changes led to a 32 percent increase in risk to people and a 122 percent increase in losses of capital stock due to flooding. Then, from 2010 to 2020, despite a smaller mangrove loss (0.66 percent), a 12 percent growth in population, and a 40 percent increase in capital stock, there was still a 33 percent increase in the risk to people and a 103 percent rise in capital stock losses (Figure 4.3). This complex impact happens because more people and valuable assets are moving into areas that used to be protected by mangroves but are now at risk of flooding due to a larger flooded area.

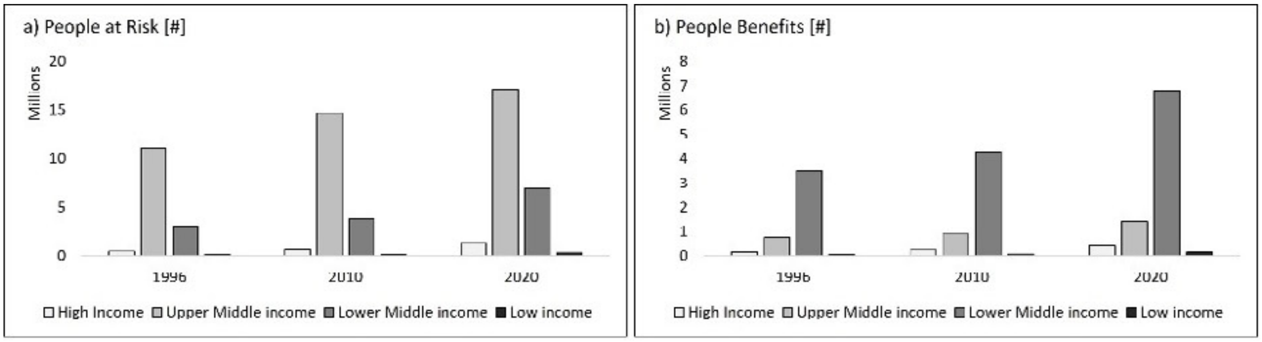
**FIGURE 4.3**: CHANGES IN TOTAL POPULATION, TOTAL CAPITAL STOCK, AND TOTAL AREA OF MANGROVES ACROSS 97 COUNTRIES (1996–2020)




## 4.2.2 Flood Risk and Mangrove Benefits by Income Level

**FIGURE 4.4**: FLOOD RISK AND MANGROVE BENEFITS TO PEOPLE AND CAPITAL STOCK BY INCOME LEVEL






If we analyze the effect of mangrove loss and socioeconomic growth by countries split by income level, we observe the following:

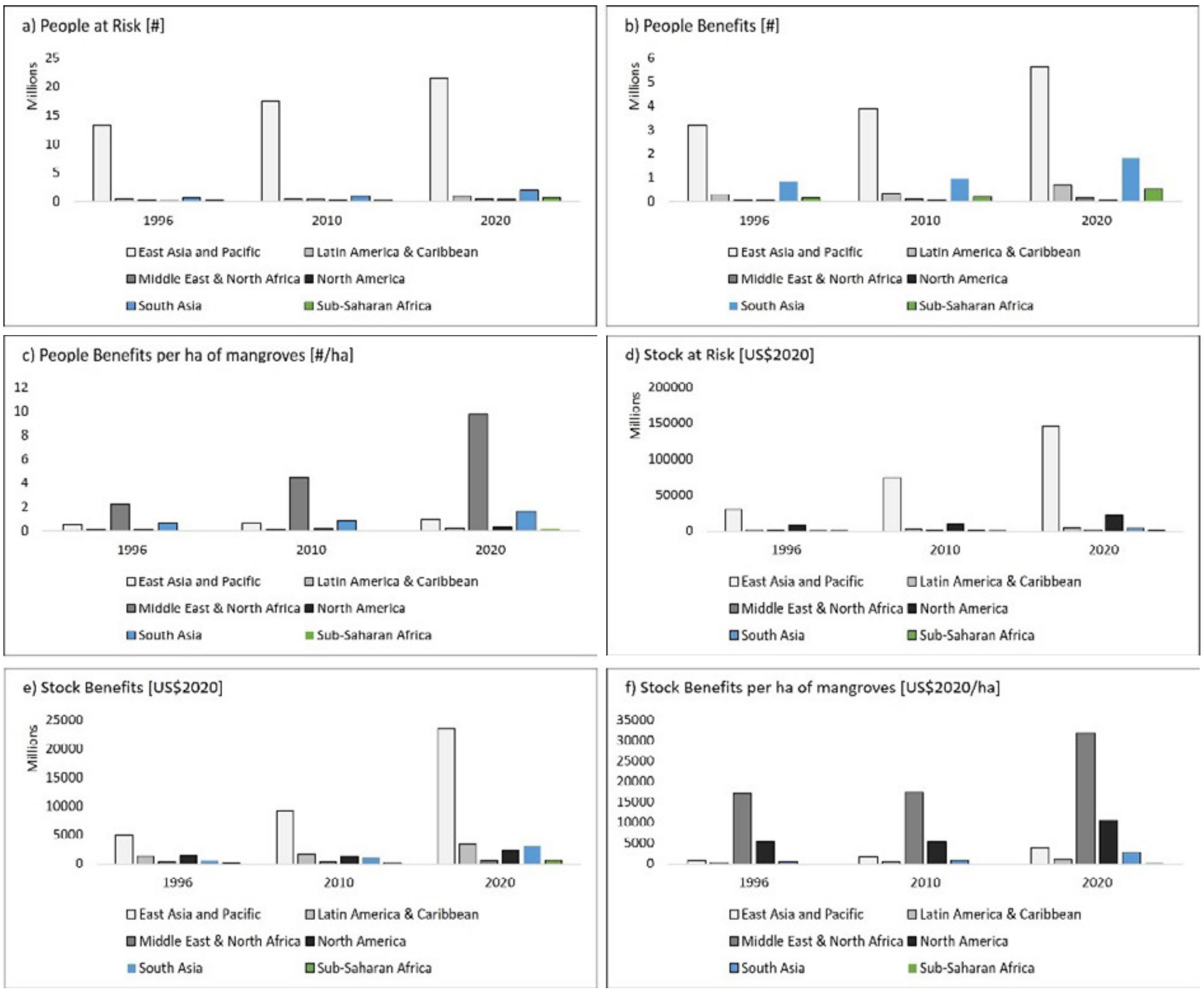
- While upper-middle income countries present the highest risk values (panels (a) and (d) in Figure 4.4), lower-middle income countries show the highest values in terms of benefits provided by mangroves (panels (b) and (e)). This means that mangroves provide more benefits to lower-income communities because in those countries more people live in the mangrove-protected belt.
- In low-income countries, each hectare of mangrove protects more people from flooding (panel (c)) than capital stock (panel (f)). Accounting for the social impact of flooding allows us to highlight the importance of mangrove habitat defending low-income communities.
- The opposite happens in high-income countries, where the economic protection of mangroves (panel (f)) is higher than the social protection (panel (c)).

If we focus on the two different periods (1996 to 2010 and 2010 to 2020) in Figure 4.4, we find differences in patterns than those observed at global scale (Figure 4.2):

- Upper-middle and low-income countries present the same pattern observed at global scale, where flood risk increases more than mangrove benefits in 1996 to 2010, and where flood risk increases less than benefits in 2010 to 2020 (panel (a) versus (b) and panel (d) versus (e) in Figure 4.4).
- High-income countries present a reverse pattern in terms of people, where the number of people at flood risk increased less than the number of people receiving benefits from mangroves in 1996 to 2010 and flood risk increased more than benefits in 2010 to 2020 (panel (a) versus (b) and panel (d) versus (e) in Figure 4.4). This is because coastal population growth in the last decade in high-income countries tends to settle in areas that are potentially flooding under extreme events.

### 4.2.3 Flood Risk and Mangrove Benefits by World Bank Region

**FIGURE 4.5**: FLOOD RISK AND MANGROVE BENEFITS TO PEOPLE AND CAPITAL STOCK BY WORLD BANK REGION




By analyzing the time evolution of flood risk and mangrove benefits by World Bank region, we found that the East Asia and Pacific region concentrates 90 percent of the global flood risk and benefits to people and capital stock (Figure 4.5). However, when these risks and benefits are weighed by the area of mangrove, the Middle East and North Africa region stands out due to the lower number of mangrove forests providing valuable protection. The per hectare value of this region exceeds $30,000/hectare in 2020, while the North America mangroves provide the second highest value of flood protection of $10.500/hectare (panel (f) in Figure 4.5). On the opposite side, the lowest unitary value of flood protection benefits from mangroves occurs in Sub-Saharan Africa, where each hectare of mangrove protected $195 in capital stock in 2020; and Latin America and the Caribbean, with a value of $880/hectare (panel (f) in Figure 4.5).

The Middle East and North Africa is the region with the most people protected by hectare of mangrove (panel (c) in Figure 4.5). In 2020, each hectare of mangrove protected an average of 10 people in the Middle East and North Africa. In contrast, in Sub-Saharan Africa and Latin America and the Caribbean, only 0.17 people received direct protection from mangroves in 2020.

### 4.2.4 Flood Risk and Mangrove Benefits by Country

**1996–2010**

Flood risk increased substantially from 1996 to 2010. The increase in risk was driven by population and economic growth in coastal areas and countries, as well as from an increase in flooding due to mangrove decline on many coastlines. The countries with the most people annually affected by coastal flooding in 2010 were China, Vietnam, India, the Philippines, and Indonesia. Each of these five countries had more than 400,000 people at risk of flooding annually (Appendix 2, Table A2). The countries with the greatest percentage increase in annual flood risk to people from 1996 to 2010 were Eritrea, Angola, Tonga, Qatar, and Thailand (Appendix 2, Table A6). All these countries had a more than two-fold risk to people in a 15-year period (1996–2010).

The countries leading the economic risk ranking in 2010 were China, the US, Taiwan, Vietnam, and Australia. Each of these five countries was predicted to have more than $1.6 billion in flood losses annually in 2010 (Appendix 2, Table A2). In relative terms, economic flood risk increased the greatest in African countries (Sudan, Angola, Tanzania, Mozambique), where they had at least 1.5 times more economic losses in the 15-year period 1996 to 2010 (Appendix 2, Table A6).

From 1996 to 2010, 0.98 million more people (22 percent) received flood reduction benefits from mangroves annually (Figure 4.2). The countries receiving the most flood risk reduction benefits to their coastal communities from mangroves in 2010 were Vietnam, India, China, Indonesia, and the Philippines (Appendix 2, Table A2). In each of these countries, mangroves are predicted to reduce flood risk to more than 250,000 people annually. The countries where mangrove benefits increased the most from 1996–2010 were Vietnam, India, Brazil, China, and Indonesia. In each of these countries, the increase in people protected by mangroves exceeded 57,000 annually (Appendix 2, Table A4). However, 20 countries experienced a reduction in flood benefits, such as Thailand, Guyana, Puerto Rico, Haiti, and Jamaica, with more than 1,300 people at greater risk in 2010 than in 1996 (Appendix 2, Table A4).

From 1996 to 2010, we estimated that annual flood reduction benefits from mangroves to capital stock increased by $5.3 billion (59 percent) (Figure 4.2). The highest mangrove benefits in 2010 were measured in Vietnam, China, Australia, the US, and Indonesia, with all five countries receiving more than $80 million in annual capital stock protection from mangroves (Appendix 2, Table A2). The increase from 1996 to 2010 was particularly high in Vietnam, China, Puerto Rico, India, and Indonesia, with annual flood reduction benefits from mangroves to capital stock increasing by at least $246 per country (Appendix 2, Table A4). Twenty-two countries, such as Thailand, the US, the United Arab Emirates, the Philippines, and Jamaica present the reverse pattern, where mangrove benefits declined between $5.5 million and $100 million (Appendix 2, Table A4).

### 2010–2020

Between 2010 and 2020, the changes in flood risk were driven almost exclusively by socioeconomic growth rather than mangrove degradation. The total population in countries with mangroves increased by 12 percent while total capital stock grew by 40 percent in this period. In contrast, mangrove degradation slowed down to 0.66 percent globally (Figure 4.3). This overall pattern does not apply everywhere, as we will describe below.

From 2010 to 2020, the countries with the most people annually affected by coastal flooding in 2020 are the same as those in 2010. China, Vietnam, India, the Philippines, and Indonesia are the top five; all of them exceeding 700,000 people at risk of flooding annually (Appendix 2, Table A3). However, the highest percent increases in flood risk to people were observed in Grenada, the Gambia, Mayotte, and the US Virgin Islands (Appendix 2, Table A7). All these countries multiplied by 15 the risk in the 10-year period (2010–2020). In two nations, Eritrea and Kiribati, flood risk to people decreased between 2010 and 2020, where we observed a 50 percent and 39 percent risk reduction respectively (Appendix 2, Table A7). This decline is mostly explained by a reduction in the coastal population, but it can also be partially explained by the improvement in mangrove conservation and restoration. For example, Kiribati experienced no mangrove loss between 2010 and 2020, according to the GMW dataset.

From 2010 to 2020, the economic risk in mangrove areas increased more significantly than the social risk. We predicted that annual economic flood risk increased by 103 percent ($91 billion) from 2010 to 2020 across all mangrove coastlines (Figure 4.2), particularly in China, the US, Australia, Taiwan, and Vietnam, where annual flood risk was predicted to exceed $4.5 billion per country in all these countries in 2020 (Appendix 2, Table A3). The countries with the highest relative increase in the economic risk of flooding between 2010 and 2020 were Grenada, the Gambia, Guyana, and Equatorial Guinea (Appendix 2, Table A7); in each of these countries annual economic flood risk multiplied by more than 15 from 2010 to 2020. In the same period, there are seven countries where flood risk to capital stock decreased. The top five countries are Sudan, Somalia, Kiribati, Seychelles, and Timor Leste, all of them with more than 47 percent in flood risk reduction (Appendix 2, Table A7). Three of these five countries did not experience significant mangrove loss greater than 0.22 percent from 2010 to 2020.

From 2010 to 2020, 3.4 million (61 percent) more people received annual flood reduction benefits from mangroves (Figure 4.2). The countries receiving the most benefits to coastal populations in 2020 were Vietnam, India, China, Bangladesh, and Indonesia;, with all five countries exceeding 450,000 people protected annually by mangroves (Appendix 2, Table A3). The countries where mangrove benefits increased the most from 2010 to 2020 were Vietnam, Bangladesh, India, China, and Cameroon. In each of these countries, the increase in people protected by mangroves exceeded 145,000 more people protected in 2020 than in 2010 (Appendix 2, Table A5). However, there were seven countries where mangrove benefits declined in this five-year period, such as in Malaysia, Myanmar, Taiwan, Pakistan, Colombia, Jamaica, and French Polynesia (Appendix 2, Table A5).

From 2010 to 2020, we estimated that annual flood reduction benefits from mangroves to capital stock increased by $20.5 billion (142 percent) globally

(Figure 4.2). The countries receiving the highest economic benefits from mangroves in 2020 were China, Vietnam, Australia, the US, and India, with the five countries exceeding $1,620 million in flood protection benefits every year (Appendix 2, Table A3). The highest increase in benefits between 2010 and 2020 was observed in China, Vietnam, Australia, the US, and Bangladesh, each with more than $1,170 million more benefits in 2020 than in 2010 (Appendix 2, Table A5). On the other hand, the four countries with the highest reduction in economic benefits of mangroves were Jamaica, Timor Leste, Belize, and Pakistan, all of them with a benefit reduction up to $7.5 million (Appendix 2, Table A5).

## 4.3 MANGROVE ASSET VALUE AND CHANGING WEALTH

Following the same approach as the previous CWON report, we are interested in the annual benefits from mangroves and the asset value of mangroves. Some assets, like manufactured capital, are traded in markets with market prices established that represent the value of the asset. But mangroves and the services they provide, like much of natural capital, are not (yet) traded in markets.

For assets like mangroves that do not have market prices, we rely on the economic definition of asset value: the discounted sum of the services mangroves can be expected to generate over their lifetime. This approach has two major components, i) estimation of the value of services using non-market valuation techniques like the expected damage function that was applied to estimate annual flood protection benefits, and ii) projections of the generation of these services in the future.

The previous sections described how coastal protection services are measured and valued over past periods. We now turn to the second component of asset valuation, projections about the generation of protection services by mangroves in the future. This requires the following information:

- A discount rate: 4 percent is used to discount all other assets in CWON so we will apply the same discount to mangrove assets.
- Lifetime over which coastal protection services will be valued: Following international accepted approaches and best practice for valuing natural capital and ecosystem assets (United Nations et al. 2014 and 2021; United Nations Department of Economics, 2021; Ramachandra, 2021), we have assumed a 100-year project lifespan for these coastal habitat assets, which is consistent with other infrastructure assets. Given that these habitats have survived for millennia in these environments (and past sea levels), this is a reasonable assumption. Of course, it will be a management choice to help keep these natural defenses in place over this time period.

The present value (2020) of the global flood reduction benefits from mangroves (100-year asset at 4 percent discount rate) is $855 billion. The countries with the greatest present value of mangroves for flood reduction are China, Vietnam, Australia, the US, and India (Table 4.1).

The increase in the wealth of mangroves for flood risk reduction from 1996 to 2010 was estimated to be over $130 billion (Table 4.1). The countries receiving the greatest increases in wealth in absolute values (US dollars) are Vietnam, China, Puerto Rico, India, and Indonesia (Appendix 2, Table A4), and in relative values (percent) were Somalia, Djibouti, the Solomon Islands, Vietnam, and Equatorial Guinea (Appendix 2, Table A6). Despite mangrove losses, most countries still saw increases in the asset value or wealth of mangroves for flood risk reduction, largely because of overall increases in flood risk (growth of people and assets on coastlines). However, some nations (22) saw overall losses in mangrove wealth for flood risk reduction, including, most notably, Thailand, the US, Timor Leste, the United Arab Emirates, and Ecuador (Appendix 2, Table A4).

The increase in the wealth of mangroves for flood risk reduction from 2010 to 2020 was estimated to be over $502 billion (Table 4.1). The countries receiving the greatest increases in wealth in absolute values (US dollars) are China, Vietnam, Australia, the US, and Bangladesh (Appendix 2, Table A5), and in relative values (percent) were South Africa, Guyana, Vanuatu, Grenada, and St Lucie (Appendix 2, Table A7). The countries that presented overall losses (four) in mangrove wealth for flood risk reduction were Jamaica, Timor Leste, Belize, and Pakistan (Appendix 2, Table A5).

**TABLE 4.1**: TOP 20 COUNTRIES IN MANGROVE ASSET VALUE (100YRS AT 4% DISCOUNT) AND ANNUAL EXPECTED BENEFIT FOR FLOOD PROTECTION

| COUNTRY | ANNUAL EXPECTED BENEFIT 2020 (# PEOPLE) | ANNUAL EXPECTED BENEFIT 2020 (CAPITAL STOCK) | PRESENT VALUE 1996 | PRESENT VALUE 2010 | PRESENT VALUE 2020 | CHANGE IN PRESENT VALUE 1996–2010 | CHANGE IN PRESENT VALUE 2010–2020 |
|---|---|---|---|---|---|---|---|
| China | 764,842 | 7,463,666,893 | 22,325,626,254 | 57,590,390,949 | 182,897,149,728 | 157.96% | 217.58% |
| Vietnam | 3,673,309 | 7,418,425,588 | 21,322,836,434 | 80,523,754,704 | 181,788,511,594 | 277.64% | 125.76% |
| Australia | 111,606 | 5,072,180,073 | 39,671,971,954 | 41,626,768,977 | 124,293,767,602 | 4.93% | 198.59% |
| The US | 64,247 | 2,436,538,383 | 31,208,751,490 | 29,457,160,897 | 59,707,370,632 | -5.61% | 102.69% |
| India | 1,144,050 | 1,620,261,180 | 10,407,317,477 | 18,292,841,975 | 39,704,498,591 | 75.77% | 117.05% |
| Indonesia | 489,596 | 1,532,916,500 | 13,879,234,598 | 19,908,597,438 | 37,564,117,295 | 43.44% | 88.68% |
| Bangladesh | 621,358 | 1,354,057,650 | 2,260,971,180 | 4,473,494,384 | 33,181,181,355 | 97.86% | 641.73% |
| Mexico | 161,141 | 1,311,000,444 | 11,581,011,139 | 13,741,068,381 | 32,126,064,565 | 18.65% | 133.80% |
| Puerto Rico | 17,258 | 996,394,598 | 9,324,186,523 | 19,060,043,528 | 24,416,648,625 | 104.42% | 28.10% |
| Brazil | 265,511 | 773,487,112 | 7,430,052,752 | 9,297,772,021 | 18,954,300,904 | 25.14% | 103.86% |
| Philippines | 327,137 | 591,802,185 | 12,182,335,903 | 12,045,729,307 | 14,502,111,950 | -1.12% | 20.39% |
| Suriname | 69,710 | 505,220,635 | 4,950,349,657 | 7,299,683,830 | 12,380,431,154 | 47.46% | 69.60% |
| Japan | 2,485 | 411,913,542 | 1,202,150,313 | 913,169,304 | 10,093,940,934 | -24.04% | 1005.37% |
| U. A. Emirates | 111,891 | 308,394,623 | 7,988,337,549 | 7,316,262,099 | 7,557,209,927 | -8.41% | 3.29% |
| Taiwan | 70,762 | 271,882,632 | 3,288,095,836 | 6,250,250,190 | 6,662,483,625 | 90.09% | 6.60% |
| New Caledonia | 1,384 | 251,396,603 | 865,343,094 | 2,833,844,905 | 6,160,473,504 | 227.48% | 117.39% |
| New Zealand | 1,186 | 223,056,032 | 1,023,807,610 | 1,104,894,922 | 5,465,987,840 | 7.92% | 394.71% |
| Thailand | 23,646 | 211,367,279 | 4,626,181,186 | 2,160,197,680 | 5,179,554,960 | -53.30% | 139.77% |
| Cuba | 9,227 | 157,240,605 | 1,175,008,404 | 1,114,094,784 | 3,853,180,868 | -5.18% | 245.86% |
| Ecuador | 16,398 | 144,993,398 | 1,417,540,996 | 1,006,511,124 | 3,553,063,073 | -29.00% | 253.01% |
| **World total** | **8,884,573** | **34.88** | **222,281** | **352,638** | **854,824** | **58.64%** | **142.41%** |

# 5 Discussion

Traditional methods for measuring economic progress, such as GDP, mainly account for market goods and services and overlook the non-market contributions of nature. As a consequence, the benefits provided by habitats are undervalued, as only those services that can be directly taken from the ecosystem are assessed, such as the fish and timber harvests. Essential non-market services such as flood protection and blue carbon sequestration, which depend on habitat preservation, are seldom evaluated. To prevent the depletion of natural capital and ensure the provision of crucial ecosystem services, policy makers and land managers should incorporate these values into their decision-making processes. By conducting better valuations, decision-makers can better meet their management objectives for environmental conservation and hazard mitigation.

In recent years, there have been updates to the data on mangroves, populations, and the PWT. These updates have changed specific quantitative estimates of risk and mangrove benefits, but the overall patterns and country rankings have remained unchanged (i.e., no qualitative changes in results). Unfortunately, flood risks continue to rise in most countries owing to continued growth of coastal populations and built-up infrastructure.

However, mangrove losses did slow after 2010 and, in some countries, mangroves are increasing. As a result, the value of mangroves for flood risk reduction continues to increase. For the first time, in the period 2010 to 2020, flood protection benefits from mangroves increased faster than flood risk. The phenomenon of flood protection benefits increasing at a higher rate than flood risk can be attributed to the significant population migration towards mangrove-protected areas. This coastal population migration puts substantially more people at risk of flooding if mangrove habitat is not maintained by nations. As more people settle in mangrove-protected areas, the contrast between the escalating flood risk in the absence of mangroves and the moderated flood risk with mangroves becomes more evident, resulting in the observed trend of flood protection benefits outpacing flood risk for the first time.

Interestingly, the highest per hectare economic value of mangroves occurs in high-income countries, while the highest per hectare number of people protected takes place in lower-middle income countries. This trend can be attributed to variations in both mangrove ecosystems and socioeconomic conditions. High-income countries often have more developed infrastructure and industries that benefit from mangroves' ecological services, whereas lower-middle income countries may rely heavily on these ecosystems for direct livelihoods and protection, even though the economic value per unit area may be lower.

Currently, the global flood reduction benefits from mangroves have a present value of $855 billion. The countries with the greatest present value of mangroves for flood reduction are China, Vietnam, Australia, the US, and India. The overall change in the wealth of mangroves for flood risk reduction from 1996 to 2010 was estimated at over $130 billion, and from 2010 to 2020 over $502 billion. The rapid increase in asset value observed globally is attributed to the dual impact of the protective function of mangroves and the high population density in mangrove-protected areas. Even narrow stretches of mangroves (some as small as 500m) play a significant role in diffusing a considerable amount of wave and storm energy—up to 99 percent. Even a minor reduction in the extent of mangrove coverage can have dire consequences, rendering coastal regions susceptible to substantial destruction during storm occurrences. Notably, flood protection does not follow a straightforward linear pattern.

Countries that have seen a swift escalation in both risks and benefits since 2010 or 2015 also house a substantial number of people within regions protected by mangroves. These valuable ecosystems tend to be situated in environmentally delicate zones, which, coincidentally, attract human settlements due to their proximity to water resources and economic opportunities.

The interplay between socioeconomic growth and changes in mangrove cover yields a non-linear effect on flood risk. This complexity hinders a straightforward estimation of the individual contributions of each factor to the overall change in flood risk. For instance, from 1996 to 2010 there is a 4 percent decline in mangrove cover, a 21 percent surge in population, and a substantial 72 percent increase in capital stock. These alterations resulted in a notable 32 percent escalation in risk to the population and an even more pronounced 122 percent amplification in capital stock losses attributed to flooding. In the period from 2010 to 2020, there is a relatively modest 0.66 percent reduction in mangrove cover, a 12 percent growth in population, and a 40 percent expansion in capital stock. Despite these seemingly lesser changes, the impact on flood risk remains significant. During this period, there was an additional 33 percent rise in the risk posed to the population, accompanied by a substantial 103 percent increase in capital stock losses. The observed non-linear effect is intricately linked to the influx of population and capital stock into areas previously safeguarded by mangroves, rendering these regions more susceptible to flooding due to an expanded flooded area. These findings underscore the complex dynamics at play, highlighting the close interaction between economic growth, changes in mangrove forests, and the risk of flooding. It is evident that a deeper understanding of this non-linear interaction is paramount for informed decision-making and effective risk management strategies.

A limiting aspect of these global economic analyses of changing wealth is the use of the PWT for the economic risk calculation, instead of other spatially explicit asset databases (such as GAR 15 used in Menendez et al. 2020). The PWT dataset provides aggregated capital stock data at the country level, which may not capture the spatial heterogeneity of capital distribution within specific coastal areas. This lack of spatial resolution can limit the accuracy of flood risk assessments that require fine-grained information on asset distribution and can restrict the precision of flood risk estimates and hinder the identification of vulnerable areas. The dataset assumes homogeneity in capital stock across sectors within a country. However, coastal areas often exhibit variations in infrastructure and capital assets based on their specific characteristics, such as population density, urbanization, and vulnerability. Failure to account for such variations may lead to inaccurate flood risk estimates. However, the PWT dataset provides capital stock data over a longer time horizon, allowing for analyses and comparisons across different decades or even centuries. This extended temporal coverage is valuable when examining long-term trends, assessing the evolution of capital accumulation, and understanding the dynamics of economic development over time.

The values that we provide are based on process-based evaluations of flood risk and mangrove benefits, and the quality of the final estimates depends on the available input data. Through our prior research and sensitivity analyses, we have determined that topography estimates (Menéndez et al. 2019) present the largest source of uncertainty in coastal flood risk assessments. In addition, nearshore bathymetry remains a significant gap, despite advances in remote sensing that could enhance flood risk assessments. While our results are based on global mangrove distribution data that are being improved, we still lack information on other critical factors, such as mangrove density, species, and degree of degradation, which can affect mangroves' ability to reduce flooding. In addition, limitations for global coastal flooding models still exist, including the inability to consider flooding as a multidimensional process and the difficulty in accurately representing flooding in small islands.

Mangroves provide a wide range of additional benefits, from fisheries to carbon mitigation, which can be valued and combined with flood reduction values to bolster the case for cost-effective investments in mangrove conservation and restoration.

Considering these limitations, a pragmatic approach to using the data is advisable. Since economic data is available at the national scale—the highest resolution available—the focus should be on assessing relative changes between different years and scenarios, rather than focusing only on absolute values. This approach helps mitigate the influence of underlying socioeconomic data variations, which can substantially impact absolute figures. Interpreting subnational spatial data requires careful consideration of both its advantages and limitations. Subnational data provides a finer level of detail and granularity compared to national-level data, which can offer valuable insights into regional variations and disparities. when working with subnational spatial data derived from global models downscaled to finer resolutions and then aggregated at the national scale, it introduces several nuanced considerations for interpretation:

- Resolution effects: The downscaling process can lead to variations in data quality and detail across regions. Some areas may benefit from higher resolution data, while others may experience a loss of information.
- Spatial bias: The global models used for downscaling may have inherent spatial biases or limitations that persist even at finer resolutions. Interpreters should be cautious of these biases and their potential impact on the accuracy of subnational data.
- Comparative analysis: When interpreting subnational data aggregated from global sources, it is essential to maintain a comparative perspective. This allows for the identification of regional outliers, trends, and anomalies that may not be apparent when solely focusing on national or global levels.

In Appendix 1, we have provided a comprehensive document detailing the intricacies of the data, along with a thorough explanation of the meticulous cleaning and processing procedures that were undertaken. This supplementary resource aims to transparently present the caveats associated with the data, shedding light on the measures employed to ensure its accuracy and reliability.

While this report primarily focuses on mangroves, it is important to acknowledge that the assessment of coastal protection provided by natural assets is incomplete without considering the role of coral reefs in (sub)tropical nations and marshes and oyster reefs in other nations. Coral reefs serve as natural submerged breakwaters, effectively breaking waves and attenuating wave energy (Lowe et al. 2005; Monismith 2007). Research by Ferrario et al. (2014) highlights that coral reefs can reduce incoming wave energy by up to 97 percent. Coral reefs and other coastal habitats should be included in future assessments.

# 6 Recommendations

These findings demonstrate the important role that mangroves play in protecting against flood risks and the significant economic value they hold. The results can inform decision-making on adaptation, development, and environmental conservation. The effectiveness of mangroves in reducing flood risks presents opportunities to support their conservation and restoration. Using these values, mangrove management can be supported by public funding for hazard mitigation, disaster recovery, and climate adaptation. Public and private funding opportunities for mangrove management include blue bonds, infrastructure bonds, and insurance, among other options (e.g., Airoldi et al. 2021). By assessing spatial variation in mangrove flood protection benefits, we can identify areas where managing mangroves could yield the greatest returns.

Overall, we have identified key considerations and recommendations for mangrove management for risk reduction based in part on our results and our work with field practitioners and decision-makers.

- Conserving existing mangroves is crucial as they make a significant contribution to national wealth and their value is expected to grow over time.
- Mangrove restoration is a well-established practice that can be effectively implemented on a large scale, with public and private funding. Large-scale mangrove restoration for risk reduction has already been successfully carried out in many countries, and while best practices are still evolving, current approaches are well developed.
- Efforts to restore mangroves should be expanded, and the results of this study can be used alongside project costs to identify areas where mangrove restoration could yield significant returns on investment (e.g., Beck et al. 2022).
- Accounting for the flood reduction benefits of mangroves as natural asset values can inform hazard mitigation and disaster recovery spending.
- These valuations enable funding to be prioritized for adaptation and help identify priority sites for mangrove coastal protection, either as standalone solutions or as part of hybrid approaches that combine mangrove natural defenses with built infrastructure.
- Rigorous valuations support innovative finance opportunities for mangrove conservation and restoration. For example, these results can inform risk models used by the insurance industry, which underpin the development of habitat insurance, blue bonds, and insurance incentives such as community and household premium reductions.
- These values can also support the development of catastrophic hazard bonds, resilience bonds, and blue bonds that could use the risk reduction benefits of mangroves to support habitat conservation and restoration.

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# Appendix 1: Data Review Process

## OVERALL REMARKS

- IMPORTANT: Any difference between CWON 2021 and CWON 2023 observed after 2015 must be ignored. The new CWON 2023 data between 2015-2020 is based on the 2020 data point, while the old CWON 2021 data between 2015-2020 is an extrapolation based on the period 2010-2015.

- Total # of countries in CWON 2023 before cleaning: 121 (111 in CWON 2021)

- Total # of countries in CWON 2023 AFTER cleaning: 97 (92 in CWON 2021)

- Total # of data points that need to be revised (see analysis of outliers below): 6
  - √ YEM (1996), PHL (2015), DOM (2015), PAN (2010), SLV (2015), LKA (2015)

- The missing countries in 2021 (10):
  - √ BMU, COG, COK, GUM, KIR, MDV, MHL, PYF, TUV, WLF
    blue=to remove because less 100 ha mangroves

- Countries removed from 2023 analysis (24):
  - √ ABW, AIA, ASM, BHR, BMU, BRB, COD, COK, COM, DMA, EGY, GNB
    GUM, HKG, IRN, KNA, MAF, MDV, MHL, STP, TUV, VCT, VGB, WLF

- Countries that will have different results in 2023 vs 2021 because there was no mangrove data in CWON 2021 (3):
  - √ BEN, MAC, TGO (updated mangrove data in CWON 2023)

- Countries that will have different results (>10% difference) in 2023 vs 2021 because of significant changes in mangroves or population data in 2023 vs CWON 2021 (6):
  - √ MOZ, THA, SYC, VEN, SLB, JAM

- Countries that will have different results (>10% difference) in 2023 vs 2021 because of significant changes in mangroves or stock data in 2023 vs CWON 2021 (8):

  - √ SYC, SGP, ATG, BRN, SYC, HND, JAM, SDN

- Countries with no population or economic data in PWT 10.0 (21):
  - √ ANT, CUB, ERI, FSM, GLP, GUF, KIR, MTQ, MYT, NCL, PLW, PNG
    PRI, PYF, SLB, SOM, TLS, TON, VIR, VUT, WSM

## DATA CLEANING

1. **REMOVE: Countries with Ha_mang<100**
   - The global model isn't sensitive to countries with few mangroves.
   - Countries (18): ABW, AIA, ASM, BHR, BMU, BRB, COK, COM, DMA, GUM KNA, MAF, MDV, MHL, STP, TUV, VGB, WLF
   - WHAT WE DO: We will check if these countries have risk values and neglect those.
   - Why? We don't have accurate precision, and our global model is not sensitive to areas with very few mangroves.

2. **REMOVE: Countries with Ha_mang<100 and no risk value**
   - All the countries with less than 100 ha mangroves don't have risk value
   - Countries (18): ABW, AIA, ASM, BHR, BMU, BRB, COK, COM, DMA, GUM KNA, MAF, MDV, MHL, STP, TUV, VGB, WLF
   - WHAT WE DO: Neglect these countries and remove them from the analysis.
   - Why? We don't have accurate precision, and our global model is not sensitive to areas with very few mangroves.

3. **REMOVE: Countries with risk to stock but no risk to people**
   - This is a bug in the geospatial analysis.
   - Countries: GNB
   - WHAT WE DO: Remove this country from the analysis.
   - Why? Wrongly taking stock risk values from the contiguous country (Guinea).

4. **REMOVE: Countries with benefits to stock but no benefits to people**
   - This is a bug in the geospatial analysis.
   - Countries: COD, EGY, HKG, IRN, VCT
   - WHAT WE DO: Remove these countries from the analysis.
   - Why? Same as the previous point, wrongly taking stock risk values from the contiguous countries.

## DIFFERENCE 2023 VS 2021 AFTER CLEANING

**Only differences > 10%**

### 1. Risk to people

These countries were not captured in the 2021 report.

| Country | 'BEN' | 'BEN' | 'BEN' | 'TGO' | 'TGO' | 'TGO' |
|---|---|---|---|---|---|---|
| Year | 1996 | 2010 | 2015 | 1996 | 2010 | 2015 |
| % diff | Inf | Inf | Inf | Inf | Inf | Inf |
| Abs diff | 23699 | 33041 | 38421 | 1425 | 1452 | 1132 |

Differences are explained because:

- Countries with no accurate mangrove data in the CWON 2021 but accurate now (BEN, TGO)

### 2. Benefits to people

| Country | 'BEN' | 'BEN' | 'BEN' | 'TGO' | 'LKA' | 'SLB' | 'PHL' | 'JAM' | 'MYT' | 'FSM' | 'JPN' | 'MOZ' | 'NZL' | 'DOM' | 'THA' | 'SYC' | 'VEN' | 'FJI' |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1996 | 2010 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 | 2015 |
| % diff | Inf | Inf | Inf | Inf | 362 | 72 | 71 | 37 | 33 | 29 | 28 | 15 | 15 | 14 | 13 | 12 | 11 | 10 |
| Abs diff | 164 | 166 | 3350 | 422 | 1686 | 1583 | 132912 | 970 | 59 | 59 | 213 | 3545 | 46 | 385 | 1472 | 72 | 1793 | 191 |
| % diff Mang | 2445 | 3328 | 1631 | 5608 | 6 | 1 | 4 | 4 | 16 | 9 | 4 | 3 | 3 | 0 | 15 | 112 | 1 | 4 |
| % diff Pop | 0 | 0 | 0 | 1 | 1 | 100 | 0 | 1 | NaN | NaN | 0 | 3 | 0 | 2 | 0 | 1 | 3 | 3 |

Differences are explained because:

- Countries with no accurate mangrove data in the CWON 2021 but accurate now (BEN, TGO)
- Update in mangrove data and pop data since CWON 2021 release, most likely impacting coastal communities (MOZ, THA, SYC, VEN, SLB, JAM)
- Very small absolute value difference (MYT, FSM, JPN, NZL, DOM, FIJ)

What needs to be revisited:

- Outliers: LKA (2015) and PHL (2015)

## 3. Risk to stock

| Country | 'BEN' | 'BEN' | 'BEN' | 'TGO' | 'TGO' | 'TGO' | 'SGP' | 'SGP' |
|---|---|---|---|---|---|---|---|---|
| Year | 1996 | 2010 | 2015 | 1996 | 2010 | 2015 | 2010 | 1996 |
| % diff | Inf | Inf | Inf | Inf | Inf | Inf | 35 | 10 |
| Abs diff | 34374174 | 43522276 | 55097573 | 1990829 | 1694357 | 1374299 | 187249 | 368951 |
| % diff Mang | 2445 | 3328 | 1631 | 6416 | 6605 | 5608 | 14 | 18 |
| % diff Stock | 33 | 14 | 22 | 30 | 27 | 0 | 44 | 50 |

Differences are explained because:

- Countries with no accurate mangrove data in the CWON 2021 but accurate now (BEN, TGO)
- Update in mangrove data and pop data in this report vs CWON 2021, most likely impacting coastal communities (SGP)

## 4. Benefits to stock

| Country | 'BEN' | 'BEN' | 'BEN' | 'TGO' | 'YEM' | 'SYC' | 'PHL' | 'DOM' | 'SGP' | 'ATG' | 'BRN' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1996 | 2010 | 2015 | 2015 | 1996 | 2010 | 2015 | 2015 | 1996 | 2010 | 1996 |
| % diff | Inf | Inf | Inf | Inf | 245 | 181 | 133 | 114 | 84 | 46 | 45 |
| Abs diff | 518272 | 426760 | 3052774 | 639490 | 487666 | 1471938 | 241443518 | 3125583 | 737901 | 1360157 | 683702 |
| % diff Mang | 2445 | 3328 | 1631 | 5608 | 17 | 112 | 4 | 0 | 18 | 5 | 1 |
| % diff Stock | 33 | 14 | 22 | 0 | 64 | 63 | 34 | 6 | 50 | 80 | 29 |

| Country | 'PAN' | 'ATG' | 'SLV' | 'SGP' | 'SYC' | 'BRN' | 'LKA' | 'HND' | 'JAM' | 'SDN' |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2010 | 1996 | 2015 | 2010 | 1996 | 2010 | 2015 | 2015 | 2015 | 1996 |
| % diff | 43 | 36 | 36 | 22 | 14 | 13 | 13 | 12 | 12 | 10 |
| Abs diff | 1979824 | 1146874 | 483601 | 432780 | 635805 | 176484 | 940306 | 640763 | 5575617 | 3705 |
| % diff Mang | 2 | 5 | 1 | 14 | 110 | 0 | 6 | 3 | 4 | 250 |
| % diff Stock | 4 | 71 | 11 | 44 | 63 | 34 | 37 | 14 | 66 | 637 |

Differences are explained because:

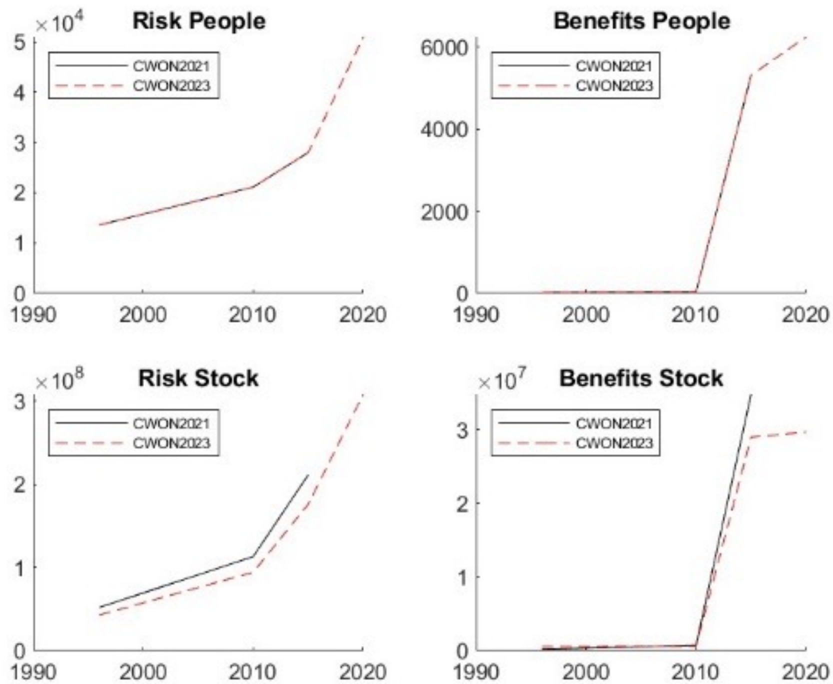
- Countries with no accurate mangrove data in the CWON 2021 but accurate now (BEN, TGO)
- Update in mangrove data and pop data since CWON 2021 release, most likely impacting coastal communities (SYC, SGP, ATG, BRN, SYC, HND, JAM, SDN)

What needs to be revisited:

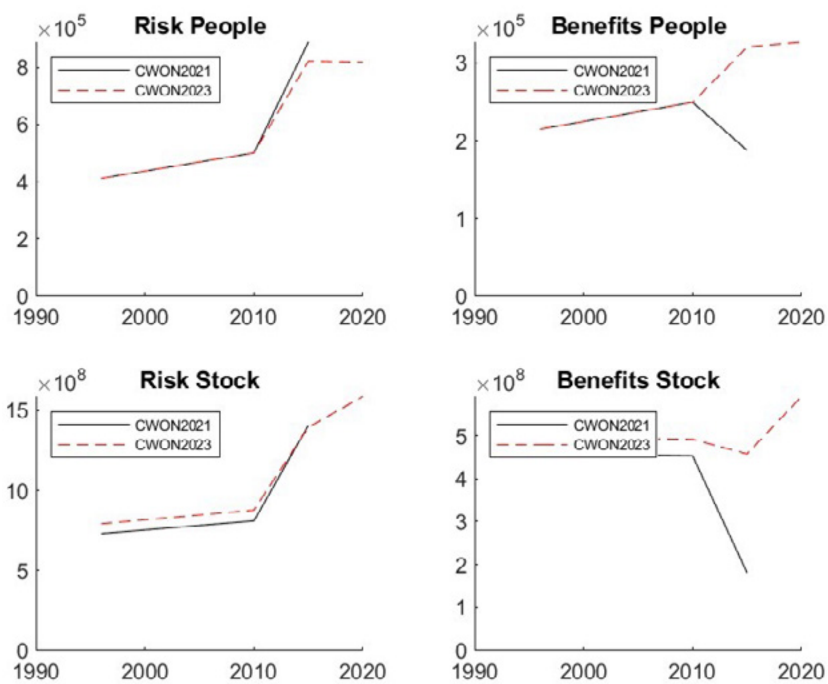
- Outliers: YEM (1996), PHL (2015), DOM (2015), PAN (2010), SLV (2015), LKA (2015)

## OUTLIERS

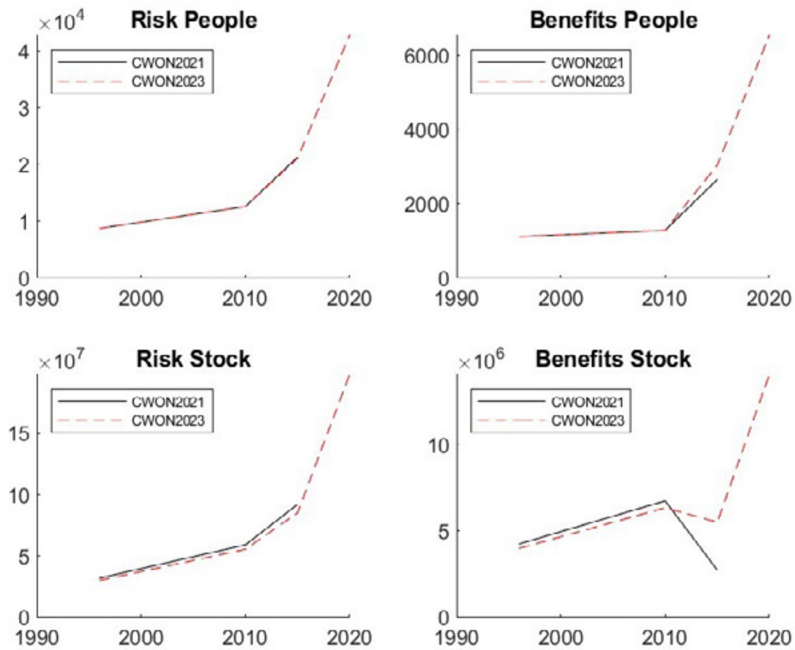
**YEM (1996): The most % difference observed in benefits to stock in 1996 is not significant in magnitude compared to the benefit to stock value observed in the following years.**



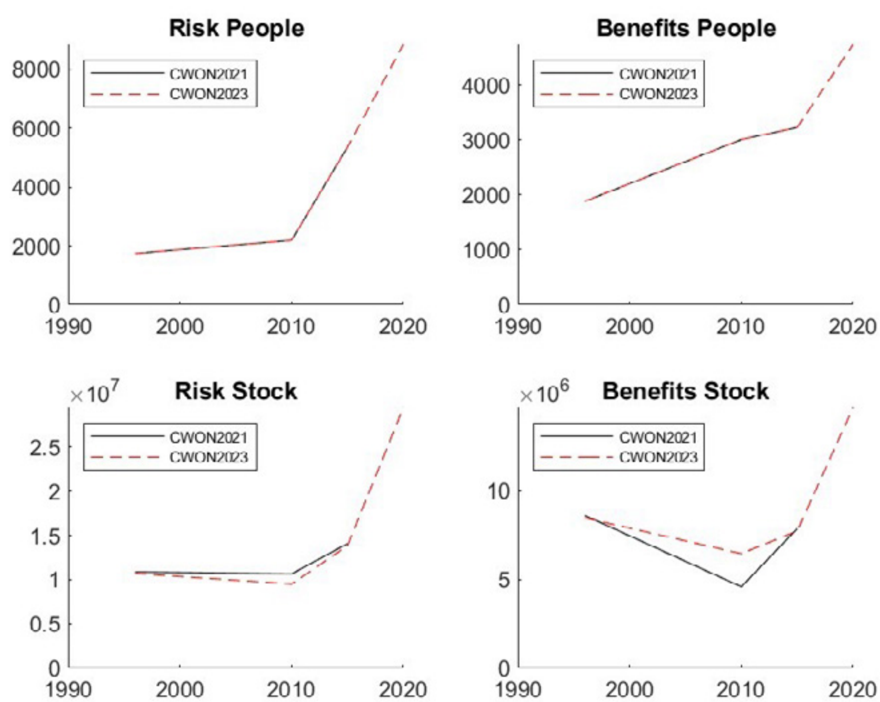

**PHL (2015): The 2015 time point calculated in CWON 2021 is incorrect.**
**The "without mangrove" scenario has been revisited, and the new 2015 value is correct.**



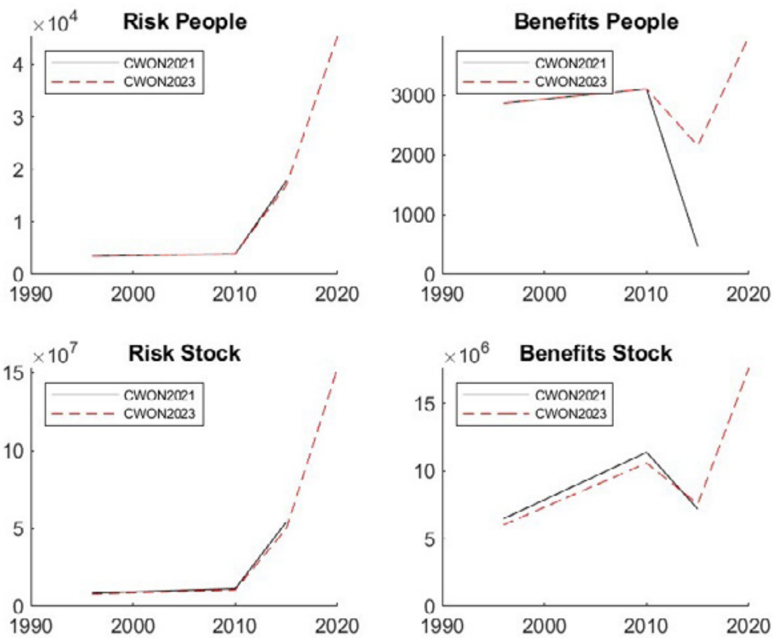
**DOM (2015): Same issue as in the Philippines. The 2015 value of the "without mangrove" scenario in CWON 2021 is incorrect and the new value obtained in CWON 2023 must be used.**




**PAN (2010): Same issue as in the Philippines. The 2010 value of the "without mangrove" scenario in CWON 2021 is incorrect and the new value obtained in CWON 2023 must be used.**



**LKA (2015): The 2015 value of people benefits "without the mangrove" scenario in CWON 2021 is underestimated, resulting in an incorrect low benefit value. The new value obtained in CWON 2023 must be used.**




## OTHER CAVEATS EXPLAINED

**1. Countries with risk value>0 but benefits=0**

- This is because mangroves are not located in populated areas.
- Countries: COG, TGO
- WHAT WE DO: Nothing; this is something that can happen. After reviewing these countries, we observed that no mangrove-protected areas are populated.

**2. Countries with no pop and economic data but risk value**

- This is because we still don't have socioeconomic data from the PWT, but we have risk to people because the GHS pop dataset used in the analysis has people distributed in these countries:
- Countries (21): ANT, CUB, ERI, FSM, GLP, GUF, KIR, MTQ, MYT, NCL, PLW, PNG. PRI, PYF, SLB, SOM, TLS, TON, VIR, VUT, WSM
- WHAT WE DO: We filled the gaps with updated PWT in the countries in green. The countries in black don't have population or capital stock data yet.

**3. Countries that increase rapidly after 2010**

- ANT, ATG, BEN, BRN, CIV, COG, DJI, ERI, GAB, GRD, JPN, KIR, LBR, NZL, PLW, PYF

**4. Countries that increase rapidly after 2015**

- ANT, AUS, BGD, CIV, CMR, COG, DOM, ECU, GMB, GNQ, GRD, LCA, NIC, PER, QAT

The rapid increase in stock risk observed in these countries is attributed to the dual impact of the protective function of mangroves and the high population density in mangrove-protected areas:

- Protective Role of Mangroves: Like a seawall that is overtopped when a flood height level is exceeded, even narrow strips of mangroves (as small as 500m) can dissipate a significant portion of wave and storm energy, up to 99 percent. Even a small reduction in mangrove coverage can lead to catastrophic consequences, leaving the coastal areas vulnerable to severe damage during storm events. In the countries listed that experience a rapid increase in risk and benefits, we identified key coastal areas with narrow strips of mangroves where flooding was triggered after 2010 and 2015. Flood protection is not linear.

- High Population Density in Mangrove Protected Areas: The countries experiencing a rapid increase in stock risk after 2010 or 2015 also exhibit a high number of people living in mangrove-protected areas. Mangroves are often located in ecologically sensitive regions, which also happen to be attractive areas for human settlements due to their proximity to water resources and livelihood opportunities.

# Appendix 2: Data Tables

**TABLE A1**: FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES IN 1996

| 1996 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 34 | China | CHN | 1996 | 29066 | 1251636186 | 10952010 | 10604835 | 428470 | 14,74 | 5169485084548 | 39516162493 | 23042962985 | 911064157 | 22 325 626 254 | 31344,67 |
| 179 | Vietnam | VNM | 1996 | 198962 | 76068743 | 1530797 | 1359172 | 2000395 | 10,05 | 214129906818 | 1235672038 | 571426313 | 870142310 | 21 322 836 434 | 4373,41 |
| 79 | India | IND | 1996 | 510157 | 982365243 | 585153 | 463970 | 625398 | 1,23 | 2409260145291 | 941166913 | 341884558 | 424701812 | 10 407 317 477 | 832,49 |
| 135 | Philippines | PHL | 1996 | 285316 | 71401749 | 481894 | 411847 | 214885 | 0,75 | 356043205229 | 2315826893 | 792246178 | 497136764 | 12 182 335 903 | 1742,41 |
| 78 | Indonesia | IDN | 1996 | 3138690 | 200756590 | 520634 | 344350 | 306753 | 0,1 | 1326463183831 | 3052363830 | 635608884 | 566383806 | 13 879 234 598 | 180,45 |
| 169 | Taiwan | TWN | 1996 | 197 | 21441432 | 223872 | 201491 | 51363 | 260,73 | 478732074637 | 7524647650 | 1869931506 | 134180615 | 3 288 095 836 | 681119,87 |
| 114 | Myanmar | MMR | 1996 | 596955 | 44452206 | 250183 | 198328 | 76106 | 0,13 | 49952821264 | 33433992 | 12591490 | 4363933 | 106 938 174 | 7,31 |
| 25 | Brazil | BRA | 1996 | 1148395 | 164614688 | 181016 | 167462 | 71223 | 0,06 | 1512112407908 | 2620583832 | 730392604 | 303205593 | 7 430 052 752 | 264,03 |
| 16 | Bangladesh | BGD | 1996 | 527667 | 117649932 | 162224 | 136294 | 161867 | 0,31 | 223833397553 | 183252954 | 87590645 | 92265712 | 2 260 971 180 | 174,86 |
| 174 | United States | USA | 1996 | 241100 | 268335003 | 132078 | 120101 | 32580 | 0,14 | 12778466659459 | 22857664786 | 7277327214 | 1273566732 | 31 208 751 490 | 5282,32 |
| 5 | United Arab Emirates | ARE | 1996 | 7591 | 2539126 | 85847 | 78235 | 38101 | 5,02 | 241257321709 | 12767127465 | 510208951 | 325988079 | 7 988 337 549 | 42944,02 |
| 177 | Venezuela | VEN | 1996 | 302537 | 22385650 | 80524 | 74482 | 11953 | 0,04 | | | | | - | |
| 92 | Cambodia | KHM | 1996 | 73406 | 10982917 | 70244 | 64045 | 35576 | 0,48 | 16862151815 | 54226683 | 22499299 | 20602220 | 504 857 380 | 280,66 |
| 122 | Malaysia | MYS | 1996 | 590057 | 21017613 | 62369 | 48310 | 27050 | 0,05 | 292432185232 | 883764750 | 136971054 | 88054789 | 2 157 782 516 | 149,23 |
| 72 | Guyana | GUY | 1996 | 39190 | 760795 | 43361 | 36794 | 36035 | 0,92 | 2751373772 | 302688563 | 90807 | 94813 | 2 323 392 | 2,42 |
| 125 | Nigeria | NGA | 1996 | 920270 | 110668794 | 55582 | 35130 | 31528 | 0,03 | 384814447644 | 272351479 | 71737782 | 46054017 | 1 128 553 640 | 50,04 |
| 108 | Madagascar | MDG | 1996 | 282644 | 13902688 | 37422 | 34522 | 9718 | 0,03 | 23797772325 | 40952686 | 17130979 | 6745564 | 165 300 039 | 23,87 |
| 110 | Mexico | MEX | 1996 | 1063983 | 93147044 | 41261 | 29193 | 64623 | 0,06 | 1402920029426 | 976238225 | 329784139 | 472597903 | 11 581 011 139 | 444,18 |
| 64 | Ghana | GHA | 1996 | 18645 | 17462496 | 33950 | 26640 | 12224 | 0,66 | 50578879417 | 201858068 | 90582434 | 46736826 | 1 145 285 874 | 2506,67 |
| 9 | Australia | AUS | 1996 | 1051177 | 18189277 | 28685 | 23843 | 32329 | 0,03 | 643221785094 | 4227517611 | 1338157923 | 1618933833 | 39 671 971 954 | 1540,12 |
| 14 | Benin | BEN | 1996 | 3054 | 6094259 | 30496 | 23699 | 164 | 0,05 | 10641466497 | 79518215 | 33990452 | 512486 | 12 558 469 | 167,81 |
| 144 | Saudi Arabia | SAU | 1996 | 9027 | 19033845 | 27348 | 23306 | 3971 | 0,44 | 852733583618 | 811353376 | 131214725 | 18957358 | 464 550 039 | 2100,07 |
| 131 | Oman | OMN | 1996 | 481 | 2236654 | 22888 | 18853 | 3450 | 7,17 | 65669326462 | 494625624 | 78944233 | 5247658 | 128 593 854 | 10909,89 |
| 117 | Mozambique | MOZ | 1996 | 325865 | 15960442 | 19821 | 18830 | 24389 | 0,07 | 8529292846 | 3593197 | 1606752 | 2866283 | 70 238 262 | 8,8 |
| 184 | Somalia | SOM | 1996 | 6083 | 7472450 | 20634 | 18683 | 149 | 0,02 | 3487368934 | 9629823 | 8719297 | 69538 | 1 704 029 | 11,43 |
| 163 | Thailand | THA | 1996 | 274943 | 60130186 | 54408 | 18306 | 30207 | 0,11 | 656305777631 | 811189417 | 131884749 | 188785202 | 4 626 181 186 | 686,63 |
| 39 | Colombia | COL | 1996 | 299604 | 37076387 | 21151 | 18073 | 14378 | 0,05 | 298293921856 | 227682040 | 61802282 | 35358071 | 866 449 494 | 118,02 |
| 35 | Côte d'Ivoire | CIV | 1996 | 6901 | 14665127 | 19241 | 14890 | 2532 | 0,37 | 42943611117 | 53036015 | 13902328 | 3671123 | 89 960 865 | 531,97 |
| 132 | Pakistan | PAK | 1996 | 107096 | 127349290 | 18381 | 13954 | 26719 | 0,25 | 431043097352 | 32898784 | 13185260 | 14919116 | 365 592 923 | 139,31 |
| 180 | Yemen | YEM | 1996 | 2007 | 15469274 | 15034 | 13551 | 22 | 0,01 | 47190213839 | 122660860 | 42807284 | 571877 | 14 013 845 | 284,94 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | Japan | JPN | 1996 | 1025 | 126644094 | 15436 | 13447 | 1491 | 1,45 | 4561300434281 | 2419961123 | 542998754 | 49057350 | 1 202 150 313 | 47860,83 |
| 146 | Senegal | SEN | 1996 | 233472 | 8912861 | 17369 | 11037 | 7127 | 0,03 | 20977338722 | 42343466 | 14571306 | 9983782 | 244 652 568 | 42,76 |
| 51 | Dominican Republic | DOM | 1996 | 19881 | 7952763 | 10030 | 8778 | 1123 | 0,06 | 60753381133 | 71422063 | 30261167 | 4010098 | 98 267 447 | 201,71 |
| 187 | Kiribati | KIR | 1996 | 146 | 82832 | 7917 | 7402 | 346 | 2,37 | 283413912 | 27088419 | 25326320 | 1183857 | 29 010 415 | 8108,61 |
| 185 | PuertoRico | PRI | 1996 | 8550 | 3724655 | 9149 | 7011 | 18565 | 2,17 | 76339157370 | 187514535 | 143694874 | 380501404 | 9 324 186 523 | 44503,09 |
| 86 | Jamaica | JAM | 1996 | 10551 | 2558637 | 8733 | 6890 | 4626 | 0,44 | 25502273532 | 221413680 | 84185356 | 53758474 | 1 317 351 351 | 5095,11 |
| 186 | Cuba | CUB | 1996 | 378885 | 10963031 | 8097 | 6632 | 5114 | 0,01 | 102791263482 | 75918864 | 62182772 | 47949743 | 1 175 008 404 | 126,55 |
| 118 | Mauritania | MRT | 1996 | 1461 | 2372901 | 8915 | 6157 | 4801 | 3,29 | 12618968152 | 18244867 | 6207254 | 5193456 | 127 265 634 | 3554,73 |
| 76 | Haiti | HTI | 1996 | 20990 | 7887304 | 6538 | 5430 | 11886 | 0,57 | 14635512145 | 15287876 | 5744449 | 13244329 | 324 552 269 | 630,98 |
| 188 | SolomonIslands | SLB | 1996 | 52098 | 386069 | 4790 | 4159 | 800 | 0,02 | 319912860 | 3969194 | 3446321 | 662913 | 16 244 682 | 12,72 |
| 53 | Ecuador | ECU | 1996 | 170891 | 11703174 | 6718 | 3973 | 7881 | 0,05 | 105853434221 | 130946024 | 28158393 | 57847013 | 1 417 540 996 | 338,5 |
| 158 | Seychelles | SYC | 1996 | 227 | 77594 | 3883 | 3702 | 140 | 0,62 | 1051999110 | 140270506 | 33943560 | 3941509 | 96 586 674 | 17363,48 |
| 170 | U.R. of Tanzania: Mainland | TZA | 1996 | 124413 | 29630526 | 5381 | 3680 | 7128 | 0,06 | 39216143965 | 5045154 | 1813584 | 3902200 | 95 623 407 | 31,36 |
| 90 | Kenya | KEN | 1996 | 57085 | 28589451 | 4480 | 3612 | 11736 | 0,21 | 113272373079 | 9925279 | 3953566 | 13044870 | 319 664 526 | 228,52 |
| 100 | Sri Lanka | LKA | 1996 | 25861 | 18367288 | 5683 | 3477 | 2867 | 0,11 | 102812165880 | 24633586 | 7837000 | 6014139 | 147 376 470 | 232,56 |
| 19 | Bahamas | BHS | 1996 | 164813 | 283978 | 3102 | 2894 | 693 | 0 | 8046482546 | 216342054 | 83454246 | 24120873 | 591 081 969 | 146,35 |
| 189 | PapuaNew-Guinea | PNG | 1996 | 467722 | 4785895 | 4330 | 2612 | 3490 | 0,01 | 11164843503 | 10101302 | 6093442 | 8141696 | 199 512 252 | 17,41 |
| 42 | Costa Rica | CRI | 1996 | 38153 | 3632362 | 2640 | 2548 | 1090 | 0,03 | 42633054668 | 33143048 | 14991188 | 6259859 | 153 397 839 | 164,07 |
| 65 | Guinea | GIN | 1996 | 262094 | 7463782 | 3551 | 2193 | 7351 | 0,03 | 17397195316 | 2575623 | 1003020 | 2922949 | 71 626 862 | 11,15 |
| 134 | Peru | PER | 1996 | 13386 | 24753824 | 2403 | 2112 | 71 | 0,01 | 154839364798 | 20286338 | 9995109 | 227682 | 5 579 347 | 17,01 |
| 145 | Sudan | SDN | 1996 | 1488 | 24782383 | 6704 | 2111 | 10 | 0,01 | 46872516272 | 1721176 | 342386 | 29458 | 721 868 | 19,8 |
| 130 | New Zealand | NZL | 1996 | 29027 | 3717349 | 2360 | 1975 | 779 | 0,03 | 101942638469 | 219787874 | 103597061 | 41779541 | 1 023 807 610 | 1439,33 |
| 133 | Panama | PAN | 1996 | 155860 | 2796291 | 1957 | 1743 | 1886 | 0,01 | 37312068291 | 28325504 | 10704552 | 8485873 | 207 946 309 | 54,45 |
| 27 | Brunei Darus-salam | BRN | 1996 | 18434 | 304622 | 2380 | 1658 | 780 | 0,04 | 20100671610 | 220416669 | 20805850 | 1860202 | 45 584 248 | 100,91 |
| 59 | Fiji | FJI | 1996 | 48541 | 784386 | 1842 | 1615 | 1428 | 0,03 | 7594613415 | 10168468 | 4032108 | 4691945 | 114 976 108 | 96,66 |
| 48 | Djibouti | DJI | 1996 | 1000 | 643654 | 2637 | 1586 | 85 | 0,09 | 1253541723 | 2441388 | 181171 | 27509 | 674 108 | 27,51 |
| 162 | Togo | TGO | 1996 | 1238 | 4348805 | 2386 | 1425 | 0 | 0 | 6646678002 | 5133260 | 1975868 | 0 | - | 0 |
| 190 | NewCaledonia | NCL | 1996 | 33008 | 197564 | 1583 | 1367 | 966 | 0,03 | 7222113698 | 57867860 | 49971804 | 35312921 | 865 343 094 | 1069,83 |
| 74 | Honduras | HND | 1996 | 90153 | 5874809 | 1355 | 1087 | 1788 | 0,02 | 27342997566 | 7280634 | 2801232 | 5156541 | 126 361 032 | 57,2 |
| 191 | Guadeloupe | GLP | 1996 | 3413 | 0 | 1367 | 1082 | 789 | 0,23 | 0 | 0 | 0 | 0 | - | 0 |
| 181 | South Africa | ZAF | 1996 | 2566 | 42241011 | 1140 | 1014 | 33 | 0,01 | 401155337743 | 13133499 | 7488676 | 75713 | 1 855 347 | 29,51 |
| 192 | FrenchGuiana | GUF | 1996 | 76023 | 0 | 1000 | 975 | 658 | 0,01 | 0 | 0 | 0 | 0 | - | 0 |
| 148 | Sierra Leone | SLE | 1996 | 182270 | 4312666 | 3431 | 950 | 3301 | 0,02 | 5455463412 | 3091113 | 543196 | 1669979 | 40 922 834 | 9,16 |
| 152 | Suriname | SUR | 1996 | 81563 | 448213 | 1803 | 940 | 26334 | 0,32 | 4182226847 | 30826452 | 7345366 | 202013869 | 4 950 349 657 | 2476,78 |
| 195 | Vanuatu | VUT | 1996 | 1585 | 174714 | 946 | 930 | 21 | 0,01 | 596502907 | 3229803 | 3175176 | 71698 | 1 756 959 | 45,24 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | MicronesiaFed-eratedStatesof | FSM | 1996 | 9084 | 110785 | 987 | 878 | 212 | 0,02 | 0 | 0 | 0 | 0 | - | 0 |
| 193 | TimorLeste | TLS | 1996 | 1373 | 831269 | 999 | 870 | 1524 | 1,11 | 27214769735 | 32706085 | 28482777 | 49893968 | 1 222 651 636 | 36339,38 |
| 8 | Antigua and Barbuda | ATG | 1996 | 860 | 70173 | 883 | 827 | 367 | 0,43 | 887477907 | 36315031 | 8301412 | 4405696 | 107 961 576 | 5122,9 |
| 149 | El Salvador | SLV | 1996 | 52696 | 5689938 | 884 | 780 | 381 | 0,01 | 34428063067 | 4820840 | 2417587 | 1411454 | 34 587 679 | 26,78 |
| 22 | Belize | BLZ | 1996 | 71678 | 213664 | 804 | 738 | 3725 | 0,05 | 1039463186 | 6374885 | 3147061 | 18016148 | 441 485 689 | 251,35 |
| 197 | Eritrea | ERI | 1996 | 9303 | 2264073 | 681 | 681 | 1141 | 0,12 | 0 | 0 | 0 | 0 | - | 0 |
| 98 | Liberia | LBR | 1996 | 20647 | 2160478 | 2437 | 648 | 1560 | 0,08 | 769809086 | 4059217 | 558342 | 1378195 | 33 772 667 | 66,75 |
| 36 | Cameroon | CMR | 1996 | 210832 | 13970813 | 990 | 637 | 6034 | 0,03 | 36806291639 | 2789470 | 651513 | 9714234 | 238 047 294 | 46,08 |
| 126 | Nicaragua | NIC | 1996 | 89009 | 4741578 | 669 | 538 | 771 | 0,01 | 19394689687 | 4074568 | 1508706 | 2221245 | 54 431 606 | 24,96 |
| 38 | Congo | COG | 1996 | 2481 | 2785810 | 458 | 458 | 0 | 0 | 10156227143 | 3505331 | 2213260 | 0 | - | 0 |
| 200 | Martinique | MTQ | 1996 | 1921 | 0 | 459 | 446 | 42 | 0,02 | 0 | 0 | 0 | 0 | - | 0 |
| 68 | Equatorial Guinea | GNQ | 1996 | 33836 | 515853 | 484 | 397 | 35 | 0 | 2583910335 | 1358673 | 513859 | 217805 | 5 337 311 | 6,44 |
| 166 | Trinidad and Tobago | TTO | 1996 | 11867 | 1257549 | 414 | 386 | 792 | 0,07 | 17749195244 | 2451489 | 1677183 | 2525316 | 61 882 866 | 212,8 |
| 2 | Angola | AGO | 1996 | 53180 | 14400719 | 470 | 366 | 411 | 0,01 | 47896152703 | 4471571 | 2371291 | 1700985 | 41 682 636 | 31,99 |
| 147 | Singapore | SGP | 1996 | 16954 | 3638187 | 512 | 360 | 183 | 0,01 | 161990287534 | 46725153 | 3282808 | 1521302 | 37 279 504 | 89,73 |
| 199 | Samoa | WSM | 1996 | 234 | 176713 | 464 | 297 | 87 | 0,37 | 0 | 0 | 0 | 0 | - | 0 |
| 99 | Saint Lucia | LCA | 1996 | 163 | 148834 | 289 | 283 | 15 | 0,09 | 1523584982 | 5393593 | 3290866 | 181294 | 4 442 609 | 1112,23 |
| 61 | Gabon | GAB | 1996 | 195378 | 1112955 | 360 | 237 | 347 | 0 | 20138303520 | 5477582 | 1047139 | 1303022 | 31 930 553 | 6,67 |
| 201 | FrenchPolynesia | PYF | 1996 | 122 | 235189 | 321 | 209 | 144 | 1,18 | | | | | - | |
| 71 | Guatemala | GTM | 1996 | 29678 | 10646674 | 214 | 207 | 331 | 0,01 | 69970120891 | 1420540 | 1042316 | 1188422 | 29 122 280 | 40,04 |
| 160 | Turks and Caicos Islands | TCA | 1996 | 20631 | 16926 | 201 | 176 | 142 | 0,01 | 204648198 | 5763406 | 2908073 | 2455669 | 60 176 166 | 119,03 |
| 140 | Qatar | QAT | 1996 | 433 | 522531 | 109 | 101 | 144 | 0,33 | 36783433466 | 7741979 | 2411838 | 3054404 | 74 848 167 | 7054,05 |
| 203 | UnitedStatesVir-ginIslands | VIR | 1996 | 281 | 108095 | 135 | 82 | 77 | 0,27 | 0 | 0 | 0 | 0 | - | 0 |
| 206 | Palau | PLW | 1996 | 5656 | 17732 | 87 | 78 | 12 | 0 | 0 | 0 | 0 | 0 | - | 0 |
| 202 | Tonga | TON | 1996 | 1055 | 100195 | 142 | 53 | 456 | 0,43 | 504796739 | 715416 | 267022 | 2297393 | 56 297 613 | 2177,62 |
| 207 | Mayotte | MYT | 1996 | 677 | 0 | 54 | 43 | 117 | 0,17 | 0 | 0 | 0 | 0 | - | 0 |
| 209 | NetherlandsAn-tilles | ANT | 1996 | 292 | 0 | 16 | 16 | 98 | 0,34 | 0 | 0 | 0 | 0 | - | 0 |
| 66 | Gambia | GMB | 1996 | 74099 | 1164091 | 555 | 14 | 638 | 0,01 | 2915091706 | 551269 | 9018 | 338159 | 8 286 586 | 4,56 |
| 70 | Grenada | GRD | 1996 | 210 | 101001 | 4 | 4 | 9 | 0,04 | 880388905 | 90171 | 37565 | 125007 | 3 063 296 | 595,27 |
| 44 | Cayman Islands | CYM | 1996 | 4684 | 34065 | 0 | 0 | 0 | 0 | 2453120847 | 0 | 0 | 0 | - | 0 |
| 105 | China, Macao SAR | MAC | 1996 | 134 | 393373 | 0 | 0 | 0 | 0 | 18337045569 | 0 | 0 | 0 | - | 0 |
| 120 | Mauritius | MUS | 1996 | 553 | 1141948 | 0 | 0 | 0 | 0 | 11349000312 | 0 | 0 | 0 | - | 0 |

**TABLE A2**: FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES IN 2010

| 2010 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 34 | China | CHN | 2010 | 24383 | 1368810615 | 14584698 | 14171614 | 486224 | 19,94 | 14446856973732 | 202060401635 | 64918046096 | 2350148676 | 57 590 390 949 | 96384,72 |
| 79 | India | IND | 2010 | 495010 | 1234281170 | 806733 | 644363 | 774727 | 1,57 | 5772294531564 | 2600992178 | 733721444 | 746494296 | 18 292 841 975 | 1508,04 |
| 174 | United States | USA | 2010 | 233110 | 309011475 | 154658 | 141312 | 36899 | 0,16 | 18069244155380 | 32524514401 | 8965434799 | 1202087823 | 29 457 160 897 | 5156,74 |
| 78 | Indonesia | IDN | 2010 | 2941621 | 241834215 | 626755 | 435851 | 364345 | 0,12 | 2124785018064 | 5836084091 | 1106307898 | 812430045 | 19 908 597 438 | 276,18 |
| 25 | Brazil | BRA | 2010 | 1127630 | 195713635 | 181407 | 167734 | 136150 | 0,12 | 2333846837042 | 3101619339 | 823564625 | 379423481 | 9 297 772 021 | 336,48 |
| 132 | Pakistan | PAK | 2010 | 92278 | 179424641 | 30753 | 22992 | 30716 | 0,33 | 728280171563 | 60689017 | 13479473 | 16161086 | 396 027 396 | 175,13 |
| 125 | Nigeria | NGA | 2010 | 895792 | 158503197 | 87349 | 56413 | 39402 | 0,04 | 921748695649 | 367104777 | 90202309 | 34497476 | 845 360 615 | 38,51 |
| 16 | Bangladesh | BGD | 2010 | 530019 | 147575430 | 257493 | 205842 | 160900 | 0,3 | 482195626425 | 639539152 | 277450025 | 182554359 | 4 473 494 384 | 344,43 |
| 88 | Japan | JPN | 2010 | 1002 | 128542353 | 16489 | 14455 | 1003 | 1 | 4980063550992 | 3046502318 | 668524486 | 37264613 | 913 169 304 | 37190,23 |
| 110 | Mexico | MEX | 2010 | 1002966 | 114092963 | 54790 | 41671 | 75238 | 0,08 | 1964671677829 | 1607402218 | 497507398 | 560745519 | 13 741 068 381 | 559,09 |
| 135 | Philippines | PHL | 2010 | 270166 | 93966780 | 567216 | 500565 | 249445 | 0,92 | 638113930890 | 3117779988 | 877535502 | 491562122 | 12 045 729 307 | 1819,48 |
| 179 | Vietnam | VNM | 2010 | 187530 | 87967651 | 1766447 | 1553534 | 2459564 | 13,12 | 528931202305 | 4966744132 | 2064699763 | 3286013385 | 80 523 754 704 | 17522,6 |
| 163 | Thailand | THA | 2010 | 258898 | 67195028 | 74533 | 55307 | 8521 | 0,03 | 1008888839845 | 1224148952 | 296940857 | 88153347 | 2 160 197 680 | 340,49 |
| 181 | South Africa | ZAF | 2010 | 2616 | 51216964 | 1306 | 1158 | 39 | 0,01 | 620348171335 | 17102393 | 9675366 | 100823 | 2 470 668 | 38,54 |
| 114 | Myanmar | MMR | 2010 | 552084 | 50600818 | 343004 | 276050 | 86041 | 0,16 | 217607973209 | 254676149 | 47728715 | 14605052 | 357 896 785 | 26,45 |
| 39 | Colombia | COL | 2010 | 289011 | 45222700 | 32704 | 28750 | 18489 | 0,06 | 454385085611 | 390738781 | 90454480 | 44572515 | 1 092 249 435 | 154,22 |
| 170 | U.R. of Tanzania: Mainland | TZA | 2010 | 121556 | 43094401 | 8677 | 6338 | 7939 | 0,07 | 87287318838 | 14150753 | 5399291 | 6912988 | 169 402 764 | 56,87 |
| 90 | Kenya | KEN | 2010 | 56274 | 42030676 | 7681 | 6727 | 11930 | 0,21 | 184872696083 | 18171321 | 7978539 | 11298533 | 276 870 540 | 200,78 |
| 145 | Sudan | SDN | 2010 | 832 | 34545013 | 9454 | 4263 | 21 | 0,03 | 108619347133 | 15808043 | 2375067 | 42952 | 1 052 539 | 51,63 |
| 134 | Peru | PER | 2010 | 11168 | 29027674 | 3191 | 2765 | 91 | 0,01 | 294321054297 | 39880186 | 17093842 | 434410 | 10 645 217 | 38,9 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 2010 | 299267 | 28439940 | 110079 | 100512 | 16086 | 0,05 | | | | | - | |
| 122 | Malaysia | MYS | 2010 | 584776 | 28208035 | 70672 | 48361 | 52769 | 0,09 | 527114109460 | 1261493186 | 158256759 | 100018357 | 2 450 949 738 | 171,04 |
| 144 | Saudi Arabia | SAU | 2010 | 8112 | 27421461 | 41229 | 34961 | 5625 | 0,69 | 1255991382365 | 1616170391 | 196394747 | 21347293 | 523 115 394 | 2631,57 |
| 64 | Ghana | GHA | 2010 | 17961 | 24779619 | 41756 | 32905 | 14766 | 0,82 | 104314081136 | 278614909 | 125717540 | 63635518 | 1 559 388 305 | 3542,98 |
| 117 | Mozambique | MOZ | 2010 | 314551 | 23531574 | 25416 | 23238 | 27501 | 0,09 | 25520952048 | 9131978 | 3915405 | 6102208 | 149 534 601 | 19,4 |
| 2 | Angola | AGO | 2010 | 52341 | 23356246 | 2459 | 2041 | 1476 | 0,03 | 131616570361 | 21449056 | 7290192 | 5621128 | 137 745 736 | 107,39 |
| 180 | Yemen | YEM | 2010 | 1675 | 23154855 | 23313 | 21104 | 33 | 0,02 | 91774642577 | 326965294 | 94138600 | 620486 | 15 205 009 | 370,44 |
| 169 | Taiwan | TWN | 2010 | 212 | 23140948 | 210227 | 186109 | 83358 | 393,2 | 906267082174 | 12125102815 | 2341735210 | 255060210 | 6 250 250 190 | 1203114,2 |
| 9 | Australia | AUS | 2010 | 1000126 | 22154679 | 34063 | 28652 | 39175 | 0,04 | 1015941161100 | 6807717905 | 1605608107 | 1698705190 | 41 626 768 977 | 1698,49 |
| 108 | Madagascar | MDG | 2010 | 275202 | 21151640 | 61812 | 56818 | 17118 | 0,06 | 36200947474 | 74240070 | 27919724 | 9856259 | 241 527 617 | 35,81 |
| 35 | Côte d'Ivoire | CIV | 2010 | 6873 | 20532950 | 25464 | 20592 | 2663 | 0,39 | 56103173740 | 60885325 | 16670224 | 3283295 | 80 457 141 | 477,71 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | Cameroon | CMR | 2010 | 211898 | 20341241 | 1502 | 898 | 11990 | 0,06 | 64309759552 | 4544770 | 968674 | 10168552 | 249 180 357 | 47,99 |
| 100 | Sri Lanka | LKA | 2010 | 17938 | 20261737 | 6404 | 3860 | 3102 | 0,17 | 210171711947 | 47200552 | 10479399 | 10579614 | 259 253 430 | 589,79 |
| 53 | Ecuador | ECU | 2010 | 159993 | 15011117 | 8692 | 7683 | 7680 | 0,05 | 164418793296 | 168935748 | 36653011 | 41073706 | 1 006 511 124 | 256,72 |
| 71 | Guatemala | GTM | 2010 | 29304 | 14630417 | 248 | 225 | 380 | 0,01 | 114578203710 | 1954303 | 1431278 | 1585539 | 38 853 632 | 54,11 |
| 92 | Cambodia | KHM | 2010 | 68007 | 14312212 | 77276 | 73030 | 39337 | 0,58 | 49146059442 | 126045593 | 56069026 | 45355713 | 1 111 441 702 | 666,93 |
| 146 | Senegal | SEN | 2010 | 234932 | 12678148 | 27342 | 17289 | 11430 | 0,05 | 37557726405 | 79478324 | 15997476 | 19351007 | 474 196 407 | 82,37 |
| 184 | Somalia | SOM | 2010 | 5965 | 12026649 | 23743 | 21408 | 904 | 0,15 | 4160448440 | 8213554 | 7405794 | 312726 | 7 663 350 | 52,43 |
| 186 | Cuba | CUB | 2010 | 350286 | 11290417 | 9018 | 7076 | 5431 | 0,02 | 94514323693 | 75491470 | 59234602 | 45463980 | 1 114 094 784 | 129,79 |
| 65 | Guinea | GIN | 2010 | 260150 | 10192176 | 3784 | 2160 | 9089 | 0,03 | 27507941015 | 4727164 | 1707976 | 6249574 | 153 145 805 | 24,02 |
| 76 | Haiti | HTI | 2010 | 19114 | 9949322 | 13597 | 12302 | 9722 | 0,51 | 16072658887 | 48966039 | 20698229 | 19385464 | 475 040 776 | 1014,2 |
| 51 | Dominican Republic | DOM | 2010 | 19390 | 9695121 | 14292 | 12631 | 1294 | 0,07 | 127578324321 | 197898473 | 55712393 | 6360643 | 155 867 550 | 328,04 |
| 14 | Benin | BEN | 2010 | 2742 | 9199259 | 41889 | 33041 | 166 | 0,06 | 19074085139 | 100595504 | 43036432 | 421996 | 10 341 012 | 153,9 |
| 5 | United Arab Emirates | ARE | 2010 | 7717 | 8549988 | 232333 | 213573 | 72943 | 9,45 | 456217128221 | 17951901093 | 450554648 | 298562024 | 7 316 262 099 | 38688,87 |
| 74 | Honduras | HND | 2010 | 92650 | 8317470 | 2328 | 2051 | 2025 | 0,02 | 45929748146 | 15462756 | 6534975 | 7237867 | 177 363 924 | 78,12 |
| 189 | PapuaNew-Guinea | PNG | 2010 | 467085 | 7583269 | 4771 | 2957 | 3908 | 0,01 | 28486216511 | 17922052 | 11107840 | 14680230 | 359 739 021 | 31,43 |
| 162 | Togo | TGO | 2010 | 1274 | 6421679 | 2365 | 1452 | 0 | 0 | 8541388683 | 4237072 | 1681624 | 0 | - | 0 |
| 148 | Sierra Leone | SLE | 2010 | 180334 | 6415634 | 4003 | 1352 | 3343 | 0,02 | 9980542633 | 2680981 | 549464 | 1298506 | 31 819 888 | 7,2 |
| 149 | El Salvador | SLV | 2010 | 53459 | 6183875 | 788 | 659 | 420 | 0,01 | 47421516609 | 6644294 | 3262820 | 2119818 | 51 946 138 | 39,65 |
| 126 | Nicaragua | NIC | 2010 | 91642 | 5824065 | 873 | 717 | 949 | 0,01 | 31108024102 | 5884245 | 2139419 | 2821134 | 69 131 886 | 30,78 |
| 147 | Singapore | SGP | 2010 | 16363 | 5131172 | 1209 | 1006 | 317 | 0,02 | 347963239672 | 149117480 | 327786 | 2243956 | 54 988 140 | 137,14 |
| 42 | Costa Rica | CRI | 2010 | 38496 | 4577378 | 2792 | 2695 | 1496 | 0,04 | 79169997461 | 54694026 | 17673123 | 5731427 | 140 448 613 | 148,88 |
| 130 | New Zealand | NZL | 2010 | 30193 | 4370062 | 2749 | 2324 | 809 | 0,03 | 149768077644 | 336043977 | 144691584 | 45088552 | 1 104 894 922 | 1493,34 |
| 38 | Congo | COG | 2010 | 2449 | 4273731 | 744 | 744 | 0 | 0 | 18075276601 | 6161965 | 2192821 | 0 | - | 0 |
| 98 | Liberia | LBR | 2010 | 20701 | 3891356 | 3972 | 1087 | 2652 | 0,13 | 5091835958 | 4477524 | 636782 | 1575033 | 38 596 182 | 76,08 |
| 185 | PuertoRico | PRI | 2010 | 8625 | 3721525 | 11230 | 9566 | 14972 | 1,74 | 193334928149 | 583403643 | 496958081 | 777802257 | 19 060 043 528 | 90179,97 |
| 133 | Panama | PAN | 2010 | 156292 | 3642687 | 2591 | 2193 | 3010 | 0,02 | 80489135288 | 59395261 | 9508379 | 6462343 | 158 359 709 | 41,35 |
| 118 | Mauritania | MRT | 2010 | 1359 | 3494195 | 10399 | 7180 | 5855 | 4,31 | 18002350551 | 30747988 | 10718815 | 9012928 | 220 861 792 | 6632,03 |
| 197 | Eritrea | ERI | 2010 | 7243 | 3147727 | 9180 | 9180 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 |
| 131 | Oman | OMN | 2010 | 311 | 3041434 | 40607 | 33764 | 5185 | 16,67 | 100989599199 | 1284848368 | 107246179 | 3344165 | 81 948 760 | 10752,94 |
| 86 | Jamaica | JAM | 2010 | 10621 | 2810460 | 8767 | 7605 | 3282 | 0,31 | 26747398296 | 244536034 | 108789282 | 46400510 | 1 137 044 451 | 4368,75 |
| 140 | Qatar | QAT | 2010 | 434 | 1856327 | 443 | 397 | 580 | 1,34 | 203025574388 | 53303315 | 4903216 | 4547543 | 111 437 537 | 10478,21 |
| 66 | Gambia | GMB | 2010 | 75168 | 1793196 | 405 | 7 | 560 | 0,01 | 4906805141 | 585784 | 6724 | 414732 | 10 163 007 | 5,52 |
| 61 | Gabon | GAB | 2010 | 195438 | 1624140 | 384 | 274 | 422 | 0 | 21594976839 | 4982945 | 972298 | 1455760 | 35 673 397 | 7,45 |
| 166 | Trinidad and Tobago | TTO | 2010 | 11395 | 1328147 | 712 | 686 | 415 | 0,04 | 42641951800 | 5277469 | 1955300 | 632082 | 15 489 169 | 55,47 |
| 120 | Mauritius | MUS | 2010 | 391 | 1247955 | 0 | 0 | 0 | 0 | 21047836494 | 0 | 0 | 0 | - | 0 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 193 | TimorLeste | TLS | 2010 | 1347 | 1088486 | 1385 | 1174 | 1522 | 1,13 | 14129126078 | 17978035 | 15239143 | 19756368 | 484 129 778 | 14666,94 |
| 68 | Equatorial Guinea | GNQ | 2010 | 34004 | 943639 | 649 | 527 | 59 | 0 | 33789655963 | 20353066 | 442089 | 755486 | 18 513 184 | 22,22 |
| 59 | Fiji | FJI | 2010 | 48767 | 859818 | 1356 | 1128 | 1813 | 0,04 | 9392392987 | 9415484 | 3950336 | 6732854 | 164 988 581 | 138,06 |
| 48 | Djibouti | DJI | 2010 | 693 | 840198 | 4293 | 2554 | 110 | 0,16 | 2533400848 | 10732907 | 769688 | 115938 | 2 841 061 | 167,3 |
| 72 | Guyana | GUY | 2010 | 40390 | 749436 | 53542 | 43699 | 29326 | 0,73 | 6101135187 | 421116891 | 126335 | 82746 | 2 027 691 | 2,05 |
| 188 | SolomonIslands | SLB | 2010 | 52275 | 540394 | 6963 | 5658 | 1444 | 0,03 | 951595572 | 12261350 | 9963337 | 2542782 | 62 310 870 | 48,64 |
| 105 | China, Macao SAR | MAC | 2010 | 124 | 538219 | 0 | 0 | 0 | 0 | 52564328374 | 0 | 0 | 0 | - | 0 |
| 152 | Suriname | SUR | 2010 | 84943 | 529131 | 3888 | 2513 | 32112 | 0,38 | 7295609793 | 94614808 | 28486494 | 297885498 | 7 299 683 830 | 3506,89 |
| 27 | Brunei Darus-salam | BRN | 2010 | 18582 | 388646 | 2938 | 2138 | 986 | 0,05 | 23901175438 | 274706284 | 23770897 | 1305590 | 31 993 482 | 70,26 |
| 19 | Bahamas | BHS | 2010 | 142069 | 354942 | 4342 | 4106 | 821 | 0,01 | 10700438474 | 471402538 | 168473459 | 39444371 | 966 584 272 | 277,64 |
| 22 | Belize | BLZ | 2010 | 67513 | 322464 | 1438 | 1299 | 5490 | 0,08 | 1978480722 | 12936012 | 5276016 | 21180817 | 519 035 899 | 313,73 |
| 201 | FrenchPolynesia | PYF | 2010 | 119 | 283788 | 383 | 256 | 162 | 1,36 | | | | | - | |
| 190 | NewCaledonia | NCL | 2010 | 32148 | 249750 | 1759 | 1503 | 1061 | 0,03 | 27221465561 | 191721954 | 163819270 | 115643543 | 2 833 844 905 | 3597,22 |
| 195 | Vanuatu | VUT | 2010 | 1601 | 245453 | 857 | 838 | 19 | 0,01 | 1849825928 | 6458674 | 6315483 | 143191 | 3 508 895 | 89,44 |
| 199 | Samoa | WSM | 2010 | 240 | 194672 | 380 | 270 | 61 | 0,25 | 0 | 0 | 0 | 0 | - | 0 |
| 99 | Saint Lucia | LCA | 2010 | 162 | 174085 | 284 | 278 | 16 | 0,1 | 2022826606 | 8961406 | 3342898 | 405282 | 9 931 435 | 2501,74 |
| 203 | UnitedStates-VirginIslands | VIR | 2010 | 273 | 108357 | 132 | 76 | 78 | 0,29 | 0 | 0 | 0 | 0 | - | 0 |
| 187 | Kiribati | KIR | 2010 | 146 | 107995 | 7067 | 6418 | 424 | 2,9 | 431646817 | 28246197 | 25652199 | 1694692 | 41 528 426 | |
| 194 | MicronesiaFed-eratedStatesof | FSM | 2010 | 8997 | 107588 | 752 | 666 | 137 | 0,02 | 0 | 0 | 0 | 0 | - | 0 |
| 202 | Tonga | TON | 2010 | 1071 | 107383 | 261 | 221 | 341 | 0,32 | 964490813 | 2344245 | 1984974 | 3062788 | 75 053 617 | 2859,75 |
| 70 | Grenada | GRD | 2010 | 209 | 106233 | 3 | 3 | 10 | 0,05 | 1382088016 | 127813 | 54350 | 208927 | 5 119 756 | 999,65 |
| 158 | Seychelles | SYC | 2010 | 227 | 91264 | 4182 | 4017 | 149 | 0,66 | 1681786978 | 209231209 | 36193510 | 1734235 | 42 497 427 | 7639,8 |
| 8 | Antigua and Barbuda | ATG | 2010 | 841 | 88028 | 765 | 713 | 340 | 0,4 | 1243184861 | 50485210 | 22896669 | 4396622 | 107 739 218 | 5227,85 |
| 44 | Cayman Islands | CYM | 2010 | 4459 | 56672 | 0 | 0 | 0 | 0 | 3830571472 | 0 | 0 | 0 | - | 0 |
| 160 | Turks and Caicos Islands | TCA | 2010 | 12429 | 32660 | 433 | 408 | 89 | 0,01 | 459623272 | 38132727 | 19684138 | 5887262 | 144 267 349 | 473,67 |
| 206 | Palau | PLW | 2010 | 5702 | 18540 | 104 | 104 | 2 | 0 | 0 | 0 | 0 | 0 | - | 0 |
| 192 | FrenchGuiana | GUF | 2010 | 77846 | 0 | 1377 | 1327 | 1216 | 0,02 | 0 | 0 | 0 | 0 | - | 0 |
| 207 | Mayotte | MYT | 2010 | 692 | 0 | 93 | 73 | 164 | 0,24 | 0 | 0 | 0 | 0 | - | 0 |
| 209 | NetherlandsAn-tilles | ANT | 2010 | 237 | 0 | 27 | 27 | 144 | 0,61 | 0 | 0 | 0 | 0 | - | 0 |
| 200 | Martinique | MTQ | 2010 | 1927 | 0 | 456 | 445 | 53 | 0,03 | 0 | 0 | 0 | 0 | - | 0 |
| 191 | Guadeloupe | GLP | 2010 | 3431 | 0 | 1472 | 1334 | 484 | 0,14 | 0 | 0 | 0 | 0 | - | 0 |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | 352 638 497 469 | |

**TABLE A3**: FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES IN 2020

| 2020 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 34 | China | CHN | 2020 | 24926 | 1439919586 | 17237935 | 16077932 | 764 842 | 30,68 | 22066954093611 | 503328178904 | 121390511628 | 7 463 666 893 | 182 897 149 728 | 299433 |
| 79 | India | IND | 2020 | 492571 | 1380193228 | 1559486 | 1210902 | 1 144 050 | 2,32 | 10544231204789 | 7721477376 | 1733514554 | 1 620 261 180 | 39 704 498 591 | 3289,4 |
| 174 | United States | USA | 2020 | 231525 | 331033569 | 378332 | 329242 | 64 247 | 0,28 | 22583187924602 | 82306728605 | 21906039066 | 2 436 538 383 | 59 707 370 632 | 10523,87 |
| 78 | Indonesia | IDN | 2020 | 2913232 | 273580593 | 1145396 | 783119 | 489 596 | 0,17 | 3551482344809 | 15221306577 | 2578974892 | 1 532 916 500 | 37 564 117 295 | 526,19 |
| 132 | Pakistan | PAK | 2020 | 82083 | 220902350 | 54119 | 42299 | 21 578 | 0,26 | 1114688608941 | 103165962 | 19940747 | 15 305 644 | 375 064 791 | 186,47 |
| 25 | Brazil | BRA | 2020 | 1138408 | 212629731 | 387813 | 348868 | 265 511 | 0,23 | 2507912321150 | 7441494892 | 1789208830 | 773 487 112 | 18 954 300 904 | 679,45 |
| 125 | Nigeria | NGA | 2020 | 887472 | 206052515 | 201334 | 133742 | 94 983 | 0,11 | 1242930041098 | 964197244 | 208762747 | 93 448 379 | 2 289 952 434 | 105,3 |
| 16 | Bangladesh | BGD | 2020 | 531711 | 164715614 | 785889 | 657059 | 621 358 | 1,17 | 944499321470 | 3493814052 | 1423614981 | 1 354 057 650 | 33 181 181 355 | 2546,6 |
| 110 | Mexico | MEX | 2020 | 1004711 | 128960270 | 139412 | 104691 | 161 141 | 0,16 | 2423514373478 | 4625531937 | 1191043651 | 1 311 000 444 | 32 126 064 565 | 1304,85 |
| 88 | Japan | JPN | 2020 | 1016 | 126518410 | 37717 | 33178 | 2 485 | 2,45 | 5463369531448 | 7340739543 | 1337335759 | 411 913 542 | 10 093 940 934 | 405426,71 |
| 135 | Philippines | PHL | 2020 | 274939 | 109581836 | 921223 | 817650 | 327 137 | 1,19 | 1152134708370 | 6636454709 | 1587984994 | 591 802 185 | 14 502 111 950 | 2152,49 |
| 179 | Vietnam | VNM | 2020 | 186363 | 97378250 | 3054035 | 2467538 | 3 673 309 | 19,71 | 976490541756 | 13368713959 | 4763444998 | 7 418 425 588 | 181 788 511 594 | 39806,32 |
| 163 | Thailand | THA | 2020 | 264930 | 69822711 | 196404 | 124711 | 23 646 | 0,09 | 1368329275145 | 3799821323 | 840303431 | 211 367 279 | 5 179 554 960 | 797,82 |
| 181 | South Africa | ZAF | 2020 | 2654 | 59324022 | 10060 | 8866 | 1 603 | 0,6 | 712029114557 | 140434889 | 76226762 | 19 888 539 | 487 368 628 | 7493,8 |
| 170 | U.R. of Tanzania: Mainland | TZA | 2020 | 120155 | 58026159 | 24907 | 19894 | 10 681 | 0,09 | 166628255923 | 65544673 | 27787778 | 15 381 416 | 376 921 584 | 128,01 |
| 114 | Myanmar | MMR | 2020 | 546707 | 54382520 | 557333 | 469825 | 63 024 | 0,12 | 393081087972 | 1323031211 | 186443130 | 71 031 161 | 1 740 618 529 | 129,93 |
| 90 | Kenya | KEN | 2020 | 56260 | 53755381 | 19316 | 15358 | 34 183 | 0,61 | 316018342362 | 55593858 | 16973713 | 30 239 949 | 741 029 920 | 537,5 |
| 39 | Colombia | COL | 2020 | 289936 | 51017838 | 85513 | 71822 | 15 055 | 0,05 | 646151159225 | 1305068446 | 203611042 | 71 735 854 | 1 757 887 030 | 247,42 |
| 145 | Sudan | SDN | 2020 | 684 | 43824943 | 8327 | 6649 | 3 564 | 5,21 | 154300616960 | 17291685 | 2239910 | 999 635 | 24 496 055 | 1461,45 |
| 144 | Saudi Arabia | SAU | 2020 | 6127 | 34834300 | 105468 | 82993 | 17 490 | 2,85 | 1679407656786 | 5240755693 | 494669022 | 103 970 766 | 2 547 803 517 | 16969,28 |
| 134 | Peru | PER | 2020 | 11845 | 33031646 | 8609 | 8188 | 659 | 0,06 | 429569152836 | 153187717 | 66167515 | 5 575 666 | 136 631 690 | 470,72 |
| 2 | Angola | AGO | 2020 | 51756 | 32840803 | 12342 | 11775 | 6 739 | 0,13 | 151786681522 | 107089034 | 25544965 | 25 724 543 | 630 379 900 | 497,03 |
| 122 | Malaysia | MYS | 2020 | 579537 | 32371521 | 134338 | 106284 | 22 448 | 0,04 | 858632009547 | 3247177863 | 326202137 | 101 506 964 | 2 487 428 051 | 175,15 |
| 117 | Mozambique | MOZ | 2020 | 304897 | 31236068 | 50833 | 41997 | 28 845 | 0,09 | 41999747798 | 48988659 | 21831867 | 20 673 476 | 506 603 509 | 67,8 |
| 64 | Ghana | GHA | 2020 | 18391 | 31068610 | 92572 | 59157 | 18 397 | 1 | 196992841710 | 598480629 | 238007943 | 104 120 600 | 2 551 475 199 | 5661,5 |
| 180 | Yemen | YEM | 2020 | 1566 | 29825161 | 59110 | 50926 | 6 239 | 3,98 | 40531798299 | 764720226 | 307617994 | 29 685 563 | 727 444 692 | 18956,3 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 2020 | 300542 | 28144540 | 144021 | 128871 | 19 847 | 0,07 | | | | | - | |
| 108 | Madagascar | MDG | 2020 | 275833 | 27676301 | 113228 | 103671 | 20 020 | 0,07 | 50127560367 | 123876405 | 31042035 | 13 542 987 | 331 870 883 | 49,1 |
| 36 | Cameroon | CMR | 2020 | 211303 | 26536493 | 11569 | 9922 | 159 861 | 0,76 | 100262884445 | 38220698 | 13402059 | 86 809 675 | 2 127 270 999 | 410,83 |
| 35 | Côte d'Ivoire | CIV | 2020 | 6453 | 26363858 | 87478 | 82261 | 32 548 | 5,04 | 138705040325 | 266796665 | 96549850 | 12 464 196 | 305 435 110 | 1931,54 |
| 9 | Australia | AUS | 2020 | 988392 | 25508244 | 119134 | 98148 | 111 606 | 0,11 | 1247675517506 | 26021029061 | 5373035758 | 5 072 180 073 | 124 293 767 602 | 5131,75 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 169 | Taiwan | TWN | 2020 | 167 | 23611974 | 469337 | 389704 | 70 762 | 423,72 | 1195742591991 | 31096278116 | 5051365408 | 271 882 632 | 6 662 483 625 | |
| 100 | Sri Lanka | LKA | 2020 | 18119 | 21418703 | 51794 | 45376 | 3 985 | 0,22 | 331303280206 | 604177527 | 153022483 | 17 583 436 | 430 882 082 | 970,44 |
| 71 | Guatemala | GTM | 2020 | 29554 | 17915095 | 1757 | 1684 | 996 | 0,03 | 162903260127 | 13715393 | 8035086 | 4 633 208 | 113 536 757 | 156,77 |
| 53 | Ecuador | ECU | 2020 | 162785 | 17662966 | 35865 | 30509 | 16 398 | 0,1 | 209442935936 | 798905577 | 142529876 | 144 993 398 | 3 553 063 073 | 890,7 |
| 146 | Senegal | SEN | 2020 | 232995 | 16738405 | 50280 | 30551 | 32 980 | 0,14 | 61323779034 | 175016917 | 35195408 | 43 351 208 | 1 062 321 309 | 186,06 |
| 92 | Cambodia | KHM | 2020 | 69351 | 16723292 | 101530 | 92456 | 71 430 | 1,03 | 97311570007 | 269136301 | 116612032 | 110 580 366 | 2 709 771 758 | 1594,5 |
| 184 | Somalia | SOM | 2020 | 5886 | 16537016 | 26538 | 21804 | 2 039 | 0,35 | 4641219516 | 7448060 | 6119432 | 572 258 | 14 023 182 | 97,22 |
| 65 | Guinea | GIN | 2020 | 253417 | 13128199 | 14768 | 7795 | 21 210 | 0,08 | 49747828142 | 33535451 | 10941961 | 35 497 912 | 869 876 298 | 140,08 |
| 14 | Benin | BEN | 2020 | 2970 | 12117258 | 91341 | 70975 | 7 469 | 2,51 | 44453903282 | 244459495 | 101259778 | 6 809 478 | 166 866 252 | 2292,75 |
| 76 | Haiti | HTI | 2020 | 18837 | 11402976 | 32329 | 29641 | 32 354 | 1,72 | 19346133743 | 140521875 | 70343431 | 82 257 844 | 2 015 728 385 | 4366,82 |
| 186 | Cuba | CUB | 2020 | 342417 | 11300698 | 33617 | 29447 | 9 227 | 0,03 | 192579234168 | 572879314 | 501816853 | 157 240 605 | 3 853 180 868 | 459,21 |
| 51 | Dominican Republic | DOM | 2020 | 19270 | 10850775 | 45178 | 42807 | 6 554 | 0,34 | 213350265311 | 861913506 | 198454163 | 14 110 676 | 345 782 101 | 732,26 |
| 5 | United Arab Emirates | ARE | 2020 | 7393 | 9910099 | 323118 | 249755 | 111 891 | 15,13 | 647638636076 | 27732260735 | 499717857 | 308 394 623 | 7 557 209 927 | 41714,41 |
| 74 | Honduras | HND | 2020 | 85226 | 9904712 | 7825 | 6683 | 2 721 | 0,03 | 64976689587 | 55174221 | 23723407 | 8 703 728 | 213 284 846 | 102,13 |
| 189 | PapuaNew-Guinea | PNG | 2020 | 461059 | 9749640 | 26358 | 22150 | 8 133 | 0,02 | 46690143258 | 126226076 | 106074345 | 38 948 201 | 954 425 626 | 84,48 |
| 162 | Togo | TGO | 2020 | 1455 | 8275639 | 8215 | 4973 | 4 786 | 3,29 | 19770572881 | 17086086 | 5917452 | 2 349 117 | 57 565 110 | 1614,51 |
| 148 | Sierra Leone | SLE | 2020 | 172741 | 7976280 | 16630 | 10778 | 6 660 | 0,04 | 15545890652 | 13878968 | 6386342 | 3 624 628 | 88 821 506 | 20,98 |
| 126 | Nicaragua | NIC | 2020 | 86057 | 6625503 | 6220 | 5268 | 8 175 | 0,09 | 39336029220 | 47887833 | 19871485 | 16 609 848 | 407 024 309 | 193,01 |
| 149 | El Salvador | SLV | 2020 | 51920 | 6486360 | 2655 | 2324 | 1 222 | 0,02 | 58771070279 | 26116400 | 15432669 | 2 211 573 | 54 194 594 | 42,6 |
| 147 | Singapore | SGP | 2020 | 15222 | 5851175 | 6372 | 5046 | 1 192 | 0,08 | 490410857871 | 960621673 | 8122326 | 4 813 679 | 117 959 199 | 316,23 |
| 38 | Congo | COG | 2020 | 2500 | 5516657 | 1001 | 1001 | 1 510 | 0,6 | 16310826822 | 11226038 | 7336084 | 1 686 750 | 41 333 807 | 674,7 |
| 131 | Oman | OMN | 2020 | 387 | 5120499 | 51012 | 38018 | 14 581 | 37,68 | 132034377473 | 1579581787 | 129390724 | 30 014 604 | 735 507 841 | 77557,12 |
| 42 | Costa Rica | CRI | 2020 | 37034 | 5095681 | 4923 | 4394 | 2 729 | 0,07 | 109928199585 | 119030888 | 36367818 | 16 181 122 | 396 518 378 | 436,93 |
| 98 | Liberia | LBR | 2020 | 19726 | 5055775 | 18142 | 11220 | 5 823 | 0,3 | 7266664186 | 25975300 | 7704047 | 5 179 471 | 126 922 932 | 262,57 |
| 130 | New Zealand | NZL | 2020 | 29676 | 4822995 | 24559 | 23126 | 1 186 | 0,04 | 201472933694 | 3402247113 | 1315012005 | 223 056 032 | 5 465 987 840 | 7516,38 |
| 118 | Mauritania | MRT | 2020 | 1563 | 4648079 | 21934 | 16060 | 6 652 | 4,26 | 26841093079 | 105178233 | 31499215 | 22 558 559 | 552 797 466 | 14432,86 |
| 133 | Panama | PAN | 2020 | 152860 | 4316009 | 9396 | 8837 | 4 742 | 0,03 | 142258286551 | 432989773 | 29488915 | 14 716 690 | 360 632 474 | 96,28 |
| 197 | Eritrea | ERI | 2020 | 7175 | 3555868 | 4628 | 4570 | 6 838 | 0,95 | 0 | 0 | 0 | - | - | 0 |
| 185 | PuertoRico | PRI | 2020 | 8200 | 3281538 | 17793 | 14668 | 17 258 | 2,1 | 189460350901 | 1027282946 | 846860352 | 996 394 598 | 24 416 648 625 | 121511,54 |
| 86 | Jamaica | JAM | 2020 | 9767 | 2961711 | 12126 | 9981 | 2 804 | 0,29 | 29330849256 | 342650890 | 157691761 | 38 824 287 | 951 389 114 | 3975,05 |
| 140 | Qatar | QAT | 2020 | 460 | 2882452 | 3810 | 3051 | 6 533 | 14,2 | 283597278193 | 655662501 | 43318936 | 57 131 953 | 1 400 018 451 | 124199,9 |
| 66 | Gambia | GMB | 2020 | 74425 | 2415318 | 3197 | 2784 | 1 687 | 0,02 | 6459215166 | 4096410 | 1778693 | 1 397 478 | 34 245 197 | 18,78 |
| 61 | Gabon | GAB | 2020 | 194197 | 2225883 | 2293 | 2162 | 1 557 | 0,01 | 31052975545 | 35277709 | 4512528 | 2 956 009 | 72 436 998 | 15,22 |
| 68 | Equatorial Guinea | GNQ | 2020 | 33795 | 1402997 | 4245 | 3803 | 1 290 | 0,04 | 24417268575 | 113355638 | 7067366 | 11 432 764 | 280 159 870 | 338,3 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 166 | Trinidad and Tobago | TTO | 2020 | 11169 | 1400103 | 2831 | 3000 | 567 | 0,05 | 39559069658 | 51048847 | 16350499 | 6 937 261 | 169 997 574 | 621,12 |
| 193 | TimorLeste | TLS | 2020 | 1344 | 1299995 | 2700 | 2188 | 3 698 | 2,75 | 4782237753 | 9932378 | 8048905 | 13 603 679 | 333 358 140 | 10121,78 |
| 120 | Mauritius | MUS | 2020 | 396 | 1272151 | 0 | 0 | - | 0 | 30158458634 | 0 | 0 | - | - | 0 |
| 48 | Djibouti | DJI | 2020 | 779 | 988197 | 5709 | 4169 | 6 547 | 8,4 | 5945590252 | 27144682 | 944435 | 1 075 824 | 26 363 066 | 1381,03 |
| 59 | Fiji | FJI | 2020 | 48811 | 896423 | 6302 | 5564 | 3 911 | 0,08 | 12606096425 | 55773758 | 26223658 | 18 000 774 | 441 108 949 | 368,79 |
| 72 | Guyana | GUY | 2020 | 38703 | 786526 | 73204 | 56761 | 33 613 | 0,87 | 8928041978 | 596287984 | 26437556 | 10 643 910 | 260 829 004 | 275,02 |
| 188 | SolomonIslands | SLB | 2020 | 51928 | 691191 | 14244 | 12568 | 4 837 | 0,09 | 2268082456 | 46740433 | 41240786 | 15 872 190 | 388 948 000 | 305,66 |
| 105 | China, Macao SAR | MAC | 2020 | 122 | 649254 | 0 | 0 | - | 0 | 62706830508 | 0 | 0 | - | - | 0 |
| 152 | Suriname | SUR | 2020 | 85438 | 586754 | 6293 | 4230 | 69 710 | 0,82 | 7834100992 | 169048742 | 42509610 | 505 220 635 | 12 380 431 154 | 5913,3 |
| 27 | Brunei Darus-salam | BRN | 2020 | 18707 | 437607 | 5115 | 4636 | 1 602 | 0,09 | 25333602841 | 608827310 | 47223278 | 7 818 968 | 191 603 803 | 417,97 |
| 22 | Belize | BLZ | 2020 | 68012 | 397635 | 3628 | 3252 | 5 925 | 0,09 | 2333555212 | 35366730 | 13669276 | 19 687 220 | 482 435 306 | 289,47 |
| 19 | Bahamas | BHS | 2020 | 145902 | 393327 | 7569 | 6953 | 2 378 | 0,02 | 12077227252 | 901310859 | 321316069 | 133 727 487 | 3 276 991 935 | 916,56 |
| 195 | Vanuatu | VUT | 2020 | 1532 | 311685 | 6177 | 5656 | 1 607 | 1,05 | 2899356943 | 57459704 | 52613257 | 14 948 639 | 366 316 384 | 9757,6 |
| 201 | French Polynesia | PYF | 2020 | 126 | 301920 | 2115 | 1753 | 122 | 0,97 | | | | | - | |
| 190 | NewCaledonia | NCL | 2020 | 33481 | 271130 | 6612 | 5427 | 1 384 | 0,04 | 49249393849 | 1201036374 | 985787115 | 251 396 603 | 6 160 473 504 | 7508,63 |
| 199 | Samoa | WSM | 2020 | 231 | 214929 | 579 | 543 | 2 568 | 11,12 | 0 | 0 | 0 | - | - | 0 |
| 99 | Saint Lucia | LCA | 2020 | 162 | 183691 | 1178 | 1108 | 1 933 | 11,93 | 2381591197 | 40887955 | 24267845 | 30 791 157 | 754 537 271 | 190068,87 |
| 187 | Kiribati | KIR | 2020 | 146 | 126463 | 4934 | 3919 | 890 | 6,1 | 581128449 | 22672938 | 18008765 | 4 089 768 | 100 219 761 | 28012,11 |
| 70 | Grenada | GRD | 2020 | 209 | 112552 | 1616 | 1594 | 623 | 2,98 | 1889054893 | 60951484 | 37890019 | 18 732 052 | 459 028 915 | 89627,04 |
| 194 | MicronesiaFeder-atedStatesof | FSM | 2020 | 8711 | 112106 | 3307 | 2962 | 420 | 0,05 | 0 | 0 | 0 | - | - | 0 |
| 203 | UnitedStatesVir-ginIslands | VIR | 2020 | 274 | 106290 | 1552 | 1395 | 257 | 0,94 | 0 | 0 | 0 | - | - | 0 |
| 202 | Tonga | TON | 2020 | 1039 | 105254 | 1245 | 896 | 1 404 | 1,35 | 1380935130 | 16334431 | 11755543 | 18 420 515 | 451 394 702 | 17729,08 |
| 158 | Seychelles | SYC | 2020 | 227 | 98382 | 5641 | 5287 | 652 | 2,87 | 2646840504 | 326410103 | 25239839 | 10 276 077 | 251 815 257 | 45269,06 |
| 8 | Antigua and Barbuda | ATG | 2020 | 869 | 97950 | 1231 | 1050 | 452 | 0,52 | 1675958120 | 93134444 | 38271361 | 14 072 879 | 344 855 886 | 16194,34 |
| 44 | Cayman Islands | CYM | 2020 | 4432 | 65722 | 0 | 0 | - | 0 | 4949331518 | 0 | 0 | - | - | 0 |
| 160 | Turks and Caicos Islands | TCA | 2020 | 15037 | 38717 | 899 | 827 | 1 641 | 0,11 | 699238769 | 74687008 | 47566667 | 71 921 778 | 1 762 443 098 | 4782,99 |
| 206 | Palau | PLW | 2020 | 5687 | 17972 | 561 | 584 | 253 | 0,04 | 0 | 0 | 0 | - | - | 0 |
| 192 | FrenchGuiana | GUF | 2020 | 83100 | 0 | 3646 | 3484 | 6 074 | 0,07 | 0 | 0 | 0 | - | - | 0 |
| 207 | Mayotte | MYT | 2020 | 675 | 0 | 2270 | 2167 | 1 335 | 1,98 | 0 | 0 | 0 | - | - | 0 |
| 209 | NetherlandsAn-tilles | ANT | 2020 | 228 | 0 | 526 | 458 | 6 468 | 28,37 | 0 | 0 | 0 | - | - | 0 |
| 200 | Martinique | MTQ | 2020 | 1944 | 0 | 2419 | 2384 | 620 | 0,32 | 0 | 0 | 0 | - | - | 0 |
| 191 | Guadeloupe | GLP | 2020 | 3415 | 0 | 2766 | 2631 | 1 016 | 0,3 | 0 | 0 | 0 | - | - | 0 |

**TABLE A4**: ABSOLUTE CHANGES IN FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES BETWEEN 1996-2010

| 1996 vs 2010 (ABSOLUTE VALUE) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 79 | India | IND | 1996 | -15147 | 251915927 | 221580 | 180393 | 149329 | 0,34 | 3363034386273 | 1659825265 | 391836886 | 321792484 | 7885524497,711 | 675,55 |
| 34 | China | CHN | 1996 | -4683 | 117174429 | 3632688 | 3566779 | 57754 | 5,2 | 9277371889184 | 162544239142 | 41875083111 | 1439084519 | 35264764694,912 | 65040,05 |
| 132 | Pakistan | PAK | 1996 | -14818 | 52075351 | 12372 | 9038 | 3997 | 0,08 | 297237074211 | 27790233 | 294213 | 1241970 | 30434473,604 | 35,82 |
| 125 | Nigeria | NGA | 1996 | -24478 | 47834403 | 31767 | 21283 | 7874 | 0,01 | 536934248005 | 94753298 | 18464527 | -11556541 | -283193025,616 | -11,53 |
| 78 | Indonesia | IDN | 1996 | -197069 | 41077625 | 106121 | 91501 | 57592 | 0,02 | 798321834233 | 2783720261 | 470699014 | 246046239 | 6029362839,948 | 95,73 |
| 174 | United States | USA | 1996 | -7990 | 40676472 | 22580 | 21211 | 4319 | 0,02 | 5290777495921 | 9666849615 | 1688107585 | -71478909 | -1751590593,363 | -125,58 |
| 25 | Brazil | BRA | 1996 | -20765 | 31098947 | 391 | 272 | 64927 | 0,06 | 821734429134 | 481035507 | 93172021 | 76217888 | 1867719269,005 | 72,45 |
| 16 | Bangladesh | BGD | 1996 | 2352 | 29925498 | 95269 | 69548 | -967 | -0,01 | 258362228872 | 456286198 | 189859380 | 90288647 | 2212523204,189 | 169,57 |
| 135 | Philippines | PHL | 1996 | -15150 | 22565031 | 85322 | 88718 | 34560 | 0,17 | 282070725661 | 801953095 | 85289324 | -5574642 | -136606596,619 | 77,07 |
| 110 | Mexico | MEX | 1996 | -61017 | 20945919 | 13529 | 12478 | 10615 | 0,02 | 561751648403 | 631163993 | 167723259 | 88147616 | 2160057241,681 | 114,91 |
| 170 | U.R. of Tanzania: Mainland | TZA | 1996 | -2857 | 13463875 | 3296 | 2658 | 811 | 0,01 | 48071174873 | 9105599 | 3585707 | 3010788 | 73779356,921 | 25,51 |
| 90 | Kenya | KEN | 1996 | -811 | 13441225 | 3201 | 3115 | 194 | 0 | 71600323004 | 8246042 | 4024973 | -1746337 | -42793986,434 | -27,74 |
| 179 | Vietnam | VNM | 1996 | -11432 | 11898908 | 235650 | 194362 | 459169 | 3,07 | 314801295487 | 3731072094 | 1493273450 | 2415871075 | 59200918270,124 | 13149,19 |
| 145 | Sudan | SDN | 1996 | -656 | 9762630 | 2750 | 2152 | 11 | 0,02 | 61746830861 | 14086867 | 2032681 | 13494 | 330670,456 | 31,83 |
| 181 | South Africa | ZAF | 1996 | 50 | 8975953 | 166 | 144 | 6 | 0 | 219192833592 | 3968894 | 2186690 | 25110 | 615320,525 | 9,03 |
| 2 | Angola | AGO | 1996 | -839 | 8955527 | 1989 | 1675 | 1065 | 0,02 | 83720417658 | 16977485 | 4918901 | 3920143 | 96063100,284 | 75,4 |
| 144 | Saudi Arabia | SAU | 1996 | -915 | 8387616 | 13881 | 11655 | 1654 | 0,25 | 403257798747 | 804817015 | 65180022 | 2389935 | 58565354,778 | 531,5 |
| 39 | Colombia | COL | 1996 | -10593 | 8146313 | 11553 | 10677 | 4111 | 0,01 | 156091163755 | 163056741 | 28652198 | 9214444 | 225799940,979 | 36,2 |
| 180 | Yemen | YEM | 1996 | -332 | 7685581 | 8279 | 7553 | 11 | 0,01 | 44584428738 | 204304434 | 51331316 | 48609 | 1191163,496 | 85,5 |
| 117 | Mozambique | MOZ | 1996 | -11314 | 7571132 | 5595 | 4408 | 3112 | 0,02 | 16991659202 | 5538781 | 2308653 | 3235925 | 79296338,880 | 10,6 |
| 64 | Ghana | GHA | 1996 | -684 | 7317123 | 7806 | 6265 | 2542 | 0,16 | 53735201719 | 76756841 | 35135106 | 16898692 | 414102430,513 | 1036,31 |
| 108 | Madagascar | MDG | 1996 | -7442 | 7248952 | 24390 | 22296 | 7400 | 0,03 | 12403175149 | 33287384 | 10788745 | 3110695 | 76227577,855 | 11,94 |
| 122 | Malaysia | MYS | 1996 | -5281 | 7190422 | 8303 | 51 | 25719 | 0,04 | 234681924228 | 377728436 | 21285705 | 11963568 | 293167221,842 | 21,81 |
| 163 | Thailand | THA | 1996 | -16045 | 7064842 | 20125 | 37001 | -21686 | -0,08 | 352583062214 | 412959535 | 165056108 | -100631855 | -2465983505,857 | -346,14 |
| 36 | Cameroon | CMR | 1996 | 1066 | 6370428 | 512 | 261 | 5956 | 0,03 | 27503467913 | 1755300 | 317161 | 454318 | 11133062,134 | 1,91 |
| 114 | Myanmar | MMR | 1996 | -44871 | 6148612 | 92821 | 77722 | 9935 | 0,03 | 167655151945 | 221242157 | 35137225 | 10241119 | 250958610,825 | 19,14 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 1996 | -3270 | 6054290 | 29555 | 26030 | 4133 | 0,01 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | United Arab Emirates | ARE | 1996 | 126 | 6010862 | 146486 | 135338 | 34842 | 4,43 | 214959806512 | 5184773628 | -59654303 | -27426055 | -672075450,271 | -4255,15 |
| 35 | Côte d'Ivoire | CIV | 1996 | -28 | 5867823 | 6223 | 5702 | 131 | 0,02 | 13159562623 | 7849310 | 2767896 | -387828 | -9503724,751 | -54,26 |
| 184 | Somalia | SOM | 1996 | -118 | 4554199 | 3109 | 2725 | 755 | 0,13 | 673079506 | -1416269 | -1313503 | 243188 | 5959321,696 | 41 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 134 | Peru | PER | 1996 | -2218 | 4273850 | 788 | 653 | 20 | 0 | 139481689499 | 19593848 | 7098733 | 206728 | 5065869,433 | 21,89 |
| 71 | Guatemala | GTM | 1996 | -374 | 3983743 | 34 | 18 | 49 | 0 | 44608082819 | 533763 | 388962 | 397117 | 9731351,687 | 14,07 |
| 9 | Australia | AUS | 1996 | -51051 | 3965402 | 5378 | 4809 | 6846 | 0,01 | 372719376006 | 2580200294 | 267450184 | 79771357 | 1954797023,286 | 158,37 |
| 146 | Senegal | SEN | 1996 | 1460 | 3765287 | 9973 | 6252 | 4303 | 0,02 | 16580387683 | 37134858 | 1426170 | 9367225 | 229543839,231 | 39,61 |
| 92 | Cambodia | KHM | 1996 | -5399 | 3329295 | 7032 | 8985 | 3761 | 0,1 | 32283907627 | 71818910 | 33569727 | 24753493 | 606584321,141 | 386,27 |
| 53 | Ecuador | ECU | 1996 | -10898 | 3307943 | 1974 | 3710 | -201 | 0 | 58565359075 | 37989724 | 8494618 | -16773307 | -411029871,214 | -81,78 |
| 14 | Benin | BEN | 1996 | -312 | 3105000 | 11393 | 9342 | 2 | 0,01 | 8432618642 | 21077289 | 9045980 | -90490 | -2217457,359 | -13,91 |
| 189 | PapuaNew-Guinea | PNG | 1996 | -637 | 2797374 | 441 | 345 | 418 | 0 | 17321373008 | 7820750 | 5014398 | 6538534 | 160226769,113 | 14,02 |
| 65 | Guinea | GIN | 1996 | -1944 | 2728394 | 233 | -33 | 1738 | 0 | 10110745699 | 2151541 | 704956 | 3326625 | 81518942,289 | 12,87 |
| 74 | Honduras | HND | 1996 | 2497 | 2442661 | 973 | 964 | 237 | 0 | 18586750580 | 8182122 | 3733743 | 2081326 | 51002891,543 | 20,92 |
| 148 | Sierra Leone | SLE | 1996 | -1936 | 2102968 | 572 | 402 | 42 | 0 | 4525079221 | -410132 | 6268 | -371473 | -9102945,492 | -1,96 |
| 162 | Togo | TGO | 1996 | 36 | 2072874 | -21 | 27 | 0 | 0 | 1894710681 | -896188 | -294244 | 0 | 0 | 0 |
| 76 | Haiti | HTI | 1996 | -1876 | 2062018 | 7059 | 6872 | -2164 | -0,06 | 1437146742 | 33678163 | 14953780 | 6141135 | 150488507,016 | 383,22 |
| 88 | Japan | JPN | 1996 | -23 | 1898259 | 1053 | 1008 | -488 | -0,45 | 418763116711 | 626541195 | 125525732 | -11792737 | -288981008,359 | -10670,6 |
| 100 | Sri Lanka | LKA | 1996 | -7923 | 1894449 | 721 | 383 | 235 | 0,06 | 107359546067 | 22566966 | 2642399 | 4565475 | 111876960,297 | 357,23 |
| 51 | Dominican Republic | DOM | 1996 | -491 | 1742358 | 4262 | 3853 | 171 | 0,01 | 66824943188 | 126476410 | 25451226 | 2350545 | 57600102,868 | 126,33 |
| 98 | Liberia | LBR | 1996 | 54 | 1730878 | 1535 | 439 | 1092 | 0,05 | 4322026872 | 418307 | 78440 | 196838 | 4823514,993 | 9,33 |
| 169 | Taiwan | TWN | 1996 | 15 | 1699516 | -13645 | -15382 | 31995 | 132,47 | 427535007537 | 4600455165 | 471803704 | 120879595 | 2962154354,251 | 521994,33 |
| 147 | Singapore | SGP | 1996 | -591 | 1492985 | 697 | 646 | 134 | 0,01 | 185972952138 | 102392327 | -2955022 | 722654 | 17708635,545 | 47,41 |
| 38 | Congo | COG | 1996 | -32 | 1487921 | 286 | 286 | 0 | 0 | 7919049458 | 2656634 | -20439 | 0 | 0 | 0 |
| 140 | Qatar | QAT | 1996 | 1 | 1333796 | 334 | 296 | 436 | 1,01 | 166242140922 | 45561336 | 2491378 | 1493139 | 36589369,698 | 3424,16 |
| 118 | Mauritania | MRT | 1996 | -102 | 1121294 | 1484 | 1023 | 1054 | 1,02 | 5383382399 | 12503121 | 4511561 | 3819472 | 93596157,530 | 3077,3 |
| 126 | Nicaragua | NIC | 1996 | 2633 | 1082487 | 204 | 179 | 178 | 0 | 11713334415 | 1809677 | 630713 | 599889 | 14700279,343 | 5,82 |
| 42 | Costa Rica | CRI | 1996 | 343 | 945016 | 152 | 147 | 406 | 0,01 | 36536942793 | 21550978 | 2681935 | -528432 | -12949225,630 | -15,19 |
| 197 | Eritrea | ERI | 1996 | -2060 | 883654 | 8499 | 8499 | -1141 | -0,12 | 0 | 0 | 0 | 0 | 0 | 0 |
| 133 | Panama | PAN | 1996 | 432 | 846396 | 634 | 450 | 1124 | 0,01 | 43177066997 | 31069757 | -1196173 | -2023530 | -49586600,621 | -13,1 |
| 131 | Oman | OMN | 1996 | -170 | 804780 | 17719 | 14911 | 1735 | 9,5 | 35320272737 | 790222744 | 28301946 | -1903493 | -46645094,056 | -156,95 |
| 130 | New Zealand | NZL | 1996 | 1166 | 652713 | 389 | 349 | 30 | 0 | 47825439175 | 116256103 | 41094523 | 3309011 | 81087311,237 | 54,01 |
| 66 | Gambia | GMB | 1996 | 1069 | 629105 | -150 | -7 | -78 | 0 | 1991713435 | 34515 | -2294 | 76573 | 1876421,288 | 0,96 |
| 61 | Gabon | GAB | 1996 | 60 | 511185 | 24 | 37 | 75 | 0 | 1456673319 | -494637 | -74841 | 152738 | 3742844,537 | 0,78 |
| 149 | El Salvador | SLV | 1996 | 763 | 493937 | -96 | -121 | 39 | 0 | 12993453542 | 1823454 | 845233 | 708364 | 17358459,110 | 12,87 |
| 68 | Equatorial Guinea | GNQ | 1996 | 168 | 427786 | 165 | 130 | 24 | 0 | 31205745628 | 18994393 | -71770 | 537681 | 13175872,366 | 15,78 |
| 186 | Cuba | CUB | 1996 | -28599 | 327386 | 921 | 444 | 317 | 0,01 | -8276939789 | -427394 | -2948170 | -2485763 | -60913619,822 | 3,24 |
| 193 | TimorLeste | TLS | 1996 | -26 | 257217 | 386 | 304 | -2 | 0,02 | -13085643657 | -14728050 | -13243634 | -30137600 | -738521857,777 | -21672,44 |
| 86 | Jamaica | JAM | 1996 | 70 | 251823 | 34 | 715 | -1344 | -0,13 | 1245124764 | 23122354 | 24603926 | -7357964 | -180306900,441 | -726,36 |
| 48 | Djibouti | DJI | 1996 | -307 | 196544 | 1656 | 968 | 25 | 0,07 | 1279859125 | 8291519 | 588517 | 88429 | 2166952,556 | 139,79 |
| 188 | SolomonIs-lands | SLB | 1996 | 177 | 154325 | 2173 | 1499 | 644 | 0,01 | 631682712 | 8292156 | 6517016 | 1879869 | 46066187,960 | 35,92 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 105 | China, Macao SAR | MAC | 1996 | -10 | 144846 | 0 | 0 | 0 | 0 | 34227282805 | 0 | 0 | 0 | 0 | 0 |
| 22 | Belize | BLZ | 1996 | -4165 | 108800 | 634 | 561 | 1765 | 0,03 | 939017536 | 6561127 | 2128955 | 3164669 | 77550210,671 | 62,38 |
| 120 | Mauritius | MUS | 1996 | -162 | 106007 | 0 | 0 | 0 | 0 | 9698836182 | 0 | 0 | 0 | 0 | 0 |
| 27 | Brunei Darus-salam | BRN | 1996 | 148 | 84024 | 558 | 480 | 206 | 0,01 | 3800503828 | 54289615 | 2965047 | -554612 | -13590766,504 | -30,65 |
| 152 | Suriname | SUR | 1996 | 3380 | 80918 | 2085 | 1573 | 5778 | 0,06 | 3113382946 | 63788356 | 21141128 | 95871629 | 2349334172,500 | 1030,11 |
| 59 | Fiji | FJI | 1996 | 226 | 75432 | -486 | -487 | 385 | 0,01 | 1797779572 | -752984 | -81772 | 2040909 | 50012472,998 | 41,4 |
| 19 | Bahamas | BHS | 1996 | -22744 | 70964 | 1240 | 1212 | 128 | 0,01 | 2653955928 | 255060484 | 85019213 | 15323498 | 375502303,123 | 131,29 |
| 195 | Vanuatu | VUT | 1996 | 16 | 70739 | -89 | -92 | -2 | 0 | 1253323021 | 3228871 | 3140307 | 71493 | 1751935,893 | 44,2 |
| 166 | Trinidad and Tobago | TTO | 1996 | -472 | 70598 | 298 | 300 | -377 | -0,03 | 24892756556 | 2825980 | 278117 | -1893234 | -46393697,271 | -157,33 |
| 190 | NewCaledonia | NCL | 1996 | -860 | 52186 | 176 | 136 | 95 | 0 | 19999351863 | 133854094 | 113847466 | 80330622 | 1968501811,551 | 2527,39 |
| 201 | FrenchPoly-nesia | PYF | 1996 | -3 | 48599 | 62 | 47 | 18 | 0,18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 99 | Saint Lucia | LCA | 1996 | -1 | 25251 | -5 | -5 | 1 | 0,01 | 499241624 | 3567813 | 52032 | 223988 | 5488825,715 | 1389,51 |
| 187 | Kiribati | KIR | 1996 | 0 | 25163 | -850 | -984 | 78 | 0,53 | 148232905 | 1157778 | 325879 | 510835 | 12518011,163 | 3498,87 |
| 44 | Cayman Islands | CYM | 1996 | -225 | 22607 | 0 | 0 | 0 | 0 | 1377450625 | 0 | 0 | 0 | 0 | 0 |
| 199 | Samoa | WSM | 1996 | 6 | 17959 | -84 | -27 | -26 | -0,12 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Antigua and Barbuda | ATG | 1996 | -19 | 17855 | -118 | -114 | -27 | -0,03 | 355706954 | 14170179 | 14595257 | -9074 | -222358,361 | 104,95 |
| 160 | Turks and Cai-cos Islands | TCA | 1996 | -8202 | 15734 | 232 | 232 | -53 | 0 | 254975074 | 32369321 | 16776065 | 3431593 | 84091183,024 | 354,64 |
| 158 | Seychelles | SYC | 1996 | 0 | 13670 | 299 | 315 | 9 | 0,04 | 629787868 | 68960703 | 2249950 | -2207274 | -54089247,156 | -9723,68 |
| 202 | Tonga | TON | 1996 | 16 | 7188 | 119 | 168 | -115 | -0,11 | 459694074 | 1628829 | 1717952 | 765395 | 18756003,707 | 682,13 |
| 70 | Grenada | GRD | 1996 | -1 | 5232 | -1 | -1 | 1 | 0,01 | 501699111 | 37642 | 16785 | 83920 | 2056459,516 | 404,38 |
| 206 | Palau | PLW | 1996 | 46 | 808 | 17 | 26 | -10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 203 | UnitedStates-VirginIslands | VIR | 1996 | -8 | 262 | -3 | -6 | 1 | 0,02 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | FrenchGuiana | GUF | 1996 | 1823 | 0 | 377 | 352 | 558 | 0,01 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | Mayotte | MYT | 1996 | 15 | 0 | 39 | 30 | 47 | 0,07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | Netherland-sAntilles | ANT | 1996 | -55 | 0 | 11 | 11 | 46 | 0,27 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | Martinique | MTQ | 1996 | 6 | 0 | -3 | -1 | 11 | 0,01 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | Guadeloupe | GLP | 1996 | 18 | 0 | 105 | 252 | -305 | -0,09 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185 | PuertoRico | PRI | 1996 | 75 | -3130 | 2081 | 2555 | -3593 | -0,43 | 116995770779 | 395889108 | 353263207 | 397300853 | 9735857004,333 | 45676,88 |
| 194 | Micronesi-aFederated-Statesof | FSM | 1996 | -87 | -3197 | -235 | -212 | -75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | Guyana | GUY | 1996 | 1200 | -11359 | 10181 | 6905 | -6709 | -0,19 | 3349761415 | 118428328 | 35528 | -12067 | -295701,823 | -0,37 |

**TABLE A5**: ABSOLUTE CHANGES IN FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES BETWEEN 2010-2020

| 2010 VS 2020 (ABSOLUTE VALUE) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 179 | Vietnam | VNM | 1996 | -1167 | 9410599 | 1287588 | 914004 | 1213745 | 6,59 | 447559339451 | 8401969827 | 2698745235 | 4132412203 | 101264756890,334 | 22283,72 |
| 34 | China | CHN | 1996 | 543 | 71108971 | 2653237 | 1906318 | 278618 | 10,74 | 7620097119879 | 301267777269 | 56472465532 | 5113518217 | 125306758779,503 | 203048,28 |
| 185 | PuertoRico | PRI | 1996 | -425 | -439987 | 6563 | 5102 | 2286 | 0,36 | -3874577248 | 443879303 | 349902271 | 218592341 | 5356605096,990 | 31331,57 |
| 79 | India | IND | 1996 | -2439 | 145912058 | 752753 | 566539 | 369323 | 0,75 | 4771936673225 | 5120485198 | 999793110 | 873766884 | 21411656616,165 | 1781,36 |
| 78 | Indonesia | IDN | 1996 | -28389 | 31746378 | 518641 | 347268 | 125251 | 0,05 | 1426697326745 | 9385222486 | 1472666994 | 720486455 | 17655519857,237 | 250,01 |
| 169 | Taiwan | TWN | 1996 | -45 | 471026 | 259110 | 203595 | -12596 | 30,52 | 289475509817 | 18971175301 | 2709630198 | 16822422 | 412233434,240 | 424925,51 |
| 152 | Suriname | SUR | 1996 | 495 | 57623 | 2405 | 1717 | 37598 | 0,44 | 538491199 | 74433934 | 14023116 | 207335137 | 5080747324,259 | 2406,41 |
| 16 | Bangladesh | BGD | 1996 | 1692 | 17140184 | 528396 | 451217 | 460458 | 0,87 | 462303695045 | 2854274900 | 1146164956 | 1171503291 | 28707686971,115 | 2202,17 |
| 110 | Mexico | MEX | 1996 | 1745 | 14867307 | 84622 | 63020 | 85903 | 0,08 | 458842695649 | 3018129719 | 693536253 | 750254925 | 18384996184,733 | 745,76 |
| 190 | NewCaledonia | NCL | 1996 | 1333 | 21380 | 4853 | 3924 | 323 | 0,01 | 22027928288 | 1009314420 | 821967845 | 135753060 | 3326628599,160 | 3911,41 |
| 9 | Australia | AUS | 1996 | -11734 | 3353565 | 85071 | 69496 | 72431 | 0,07 | 231734356406 | 19213311156 | 3767427651 | 3373474883 | 82666998624,832 | 3433,26 |
| 25 | Brazil | BRA | 1996 | 10778 | 16916096 | 206406 | 181134 | 129361 | 0,11 | 174065484108 | 4339875553 | 965644205 | 394063631 | 9656528882,469 | 342,97 |
| 92 | Cambodia | KHM | 1996 | 1344 | 2411080 | 24254 | 19426 | 32093 | 0,45 | 48165510565 | 143090708 | 60543006 | 65224653 | 1598330056,355 | 927,57 |
| 64 | Ghana | GHA | 1996 | 430 | 6288991 | 50816 | 26252 | 3631 | 0,18 | 92678760574 | 319865720 | 112290403 | 40485082 | 992086893,810 | 2118,52 |
| 19 | Bahamas | BHS | 1996 | 3833 | 38385 | 3227 | 2847 | 1557 | 0,01 | 1376788778 | 429908321 | 152842610 | 94283116 | 2310407663,028 | 638,92 |
| 122 | Malaysia | MYS | 1996 | -5239 | 4163486 | 63666 | 57923 | -30321 | -0,05 | 331517900087 | 1985684677 | 167945378 | 1488607 | 36478313,042 | 4,11 |
| 114 | Myanmar | MMR | 1996 | -5377 | 3781702 | 214329 | 193775 | -23017 | -0,04 | 175473114763 | 1068355062 | 138714415 | 56426109 | 1382721744,458 | 103,48 |
| 146 | Senegal | SEN | 1996 | -1937 | 4060257 | 22938 | 13262 | 21550 | 0,09 | 23766052629 | 95538593 | 19197932 | 24000201 | 588124901,436 | 103,69 |
| 39 | Colombia | COL | 1996 | 925 | 5795138 | 52809 | 43072 | -3434 | -0,01 | 191766073614 | 914329665 | 113156562 | 27163339 | 665637594,954 | 93,2 |
| 189 | PapuaNew-Guinea | PNG | 1996 | -6026 | 2166371 | 21587 | 19193 | 4225 | 0,01 | 18203926747 | 108304024 | 94966505 | 24267971 | 594686605,018 | 53,05 |
| 76 | Haiti | HTI | 1996 | -277 | 1453654 | 18732 | 17339 | 22632 | 1,21 | 3273474856 | 91555836 | 49645202 | 62872380 | 1540687608,849 | 3352,62 |
| 100 | Sri Lanka | LKA | 1996 | 181 | 1156966 | 45390 | 41516 | 883 | 0,05 | 121131568259 | 556976975 | 142543084 | 7003822 | 171628651,086 | 380,65 |
| 2 | Angola | AGO | 1996 | -585 | 9484557 | 9883 | 9734 | 5263 | 0,1 | 20170111161 | 85639978 | 18254773 | 20103415 | 492634164,414 | 389,64 |
| 118 | Mauritania | MRT | 1996 | 204 | 1153884 | 11535 | 8880 | 797 | -0,05 | 8838742528 | 74430245 | 20780400 | 13545631 | 331935674,071 | 7800,83 |
| 160 | Turks and Caicos Islands | TCA | 1996 | 2608 | 6057 | 466 | 419 | 1552 | 0,1 | 239615497 | 36554281 | 27882529 | 66034516 | 1618175748,357 | 4309,32 |
| 65 | Guinea | GIN | 1996 | -6733 | 2936023 | 10984 | 5635 | 12121 | 0,05 | 22239887127 | 28808287 | 9233985 | 29248338 | 716730493,358 | 116,06 |
| 130 | New Zealand | NZL | 1996 | -517 | 452933 | 21810 | 20802 | 377 | 0,01 | 51704856050 | 3066203136 | 1170320421 | 177967480 | 4361092918,926 | 6023,04 |
| 117 | Mozambique | MOZ | 1996 | -9654 | 7704494 | 25417 | 18759 | 1344 | 0 | 16478795750 | 39856681 | 17916462 | 14571268 | 357068907,727 | 48,4 |
| 22 | Belize | BLZ | 1996 | 499 | 75171 | 2190 | 1953 | 435 | 0,01 | 355074490 | 22430718 | 8393260 | -1493597 | -36600592,987 | -24,26 |
| 108 | Madagascar | MDG | 1996 | 631 | 6524661 | 51416 | 46853 | 2902 | 0,01 | 13926612893 | 49636335 | 3122311 | 3686728 | 90343265,943 | 13,29 |
| 170 | U.R. of Tanzania: Mainland | TZA | 1996 | -1401 | 14931758 | 16230 | 13556 | 2742 | 0,02 | 79340937085 | 51393920 | 22388487 | 8468428 | 207518819,647 | 71,14 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 144 | Saudi Arabia | SAU | 1996 | -1985 | 7412839 | 64239 | 48032 | 11865 | 2,16 | 423416274421 | 3624585302 | 298274275 | 82623473 | 2024688123,006 | 14337,71 |
| 51 | Dominican Republic | DOM | 1996 | -120 | 1155654 | 30886 | 30176 | 5260 | 0,27 | 85771940990 | 664015033 | 142741770 | 7750033 | 189914550,893 | 404,22 |
| 74 | Honduras | HND | 1996 | -7424 | 1587242 | 5497 | 4632 | 696 | 0,01 | 19046941441 | 39711465 | 17188432 | 1465861 | 35920922,335 | 24,01 |
| 59 | Fiji | FJI | 1996 | 44 | 36605 | 4946 | 4436 | 2098 | 0,04 | 3213703438 | 46358274 | 22273322 | 11267920 | 276120368,300 | 230,73 |
| 188 | SolomonIslands | SLB | 1996 | -347 | 150797 | 7281 | 6910 | 3393 | 0,06 | 1316486884 | 34479083 | 31277449 | 13329408 | 326637129,673 | 257,02 |
| 140 | Qatar | QAT | 1996 | 26 | 1026125 | 3367 | 2654 | 5953 | 12,86 | 80571703805 | 602359186 | 38415720 | 52584410 | 1288580914,316 | 113721,69 |
| 132 | Pakistan | PAK | 1996 | -10195 | 41477709 | 23366 | 19307 | -9138 | -0,07 | 386408437378 | 42476945 | 6461274 | -855442 | -20962605,352 | 11,34 |
| 202 | Tonga | TON | 1996 | -32 | -2129 | 984 | 675 | 1063 | 1,03 | 416444317 | 13990186 | 9770569 | 15357727 | 376341084,734 | 14869,33 |
| 147 | Singapore | SGP | 1996 | -1141 | 720003 | 5163 | 4040 | 875 | 0,06 | 142447618199 | 811504193 | 7794540 | 2569723 | 62971059,538 | 179,09 |
| 149 | El Salvador | SLV | 1996 | -1539 | 302485 | 1867 | 1665 | 802 | 0,01 | 11349553670 | 19472106 | 12169849 | 91755 | 2248456,183 | 2,95 |
| 126 | Nicaragua | NIC | 1996 | -5585 | 801438 | 5347 | 4551 | 7226 | 0,08 | 8228005118 | 42003588 | 17732066 | 13788714 | 337892422,742 | 162,23 |
| 68 | Equatorial Guinea | GNQ | 1996 | -209 | 459358 | 3596 | 3276 | 1231 | 0,04 | -9372387388 | 93002572 | 6625277 | 10677278 | 261646686,682 | 316,08 |
| 187 | Kiribati | KIR | 1996 | 0 | 18468 | -2133 | -2499 | 466 | 3,2 | 149481632 | -5573259 | -7643434 | 2395076 | 58691334,978 | 16404,63 |
| 36 | Cameroon | CMR | 1996 | -595 | 6195252 | 10067 | 9024 | 147871 | 0,7 | 35953124893 | 33675928 | 12433385 | 76641123 | 1878090642,256 | 362,84 |
| 71 | Guatemala | GTM | 1996 | 250 | 3284678 | 1509 | 1459 | 616 | 0,02 | 48325056417 | 11761090 | 6603808 | 3047669 | 74683125,789 | 102,66 |
| 184 | Somalia | SOM | 1996 | -79 | 4510367 | 2795 | 396 | 1135 | 0,2 | 480771076 | -765494 | -1286362 | 259532 | 6359831,400 | 44,79 |
| 99 | Saint Lucia | LCA | 1996 | 0 | 9606 | 894 | 830 | 1917 | 11,83 | 358764591 | 31926549 | 20924947 | 30385875 | 744605836,403 | 187567,13 |
| 134 | Peru | PER | 1996 | 677 | 4003972 | 5418 | 5423 | 568 | 0,05 | 135248098539 | 113307531 | 49073673 | 5141256 | 125986473,124 | 431,82 |
| 98 | Liberia | LBR | 1996 | -975 | 1164419 | 14170 | 10133 | 3171 | 0,17 | 2174828228 | 21497776 | 7067265 | 3604438 | 88326749,575 | 186,49 |
| 61 | Gabon | GAB | 1996 | -1241 | 601743 | 1909 | 1888 | 1135 | 0,01 | 9457998706 | 30294764 | 3540230 | 1500249 | 36763600,240 | 7,77 |
| 48 | Djibouti | DJI | 1996 | 86 | 147999 | 1416 | 1615 | 6437 | 8,24 | 3412189404 | 16411775 | 174747 | 959886 | 23522005,467 | 1213,73 |
| 70 | Grenada | GRD | 1996 | 0 | 6319 | 1613 | 1591 | 613 | 2,93 | 506966877 | 60823671 | 37835669 | 18523125 | 453909159,549 | 88627,39 |
| 66 | Gambia | GMB | 1996 | -743 | 622122 | 2792 | 2777 | 1127 | 0,01 | 1552410025 | 3510626 | 1771969 | 982746 | 24082189,744 | 13,26 |
| 195 | Vanuatu | VUT | 1996 | -69 | 66232 | 5320 | 4818 | 1588 | 1,04 | 1049531015 | 51001030 | 46297774 | 14805448 | 362807488,392 | 9668,16 |
| 180 | Yemen | YEM | 1996 | -109 | 6670306 | 35797 | 29822 | 6206 | 3,96 | -51242844278 | 437754932 | 213479394 | 29065077 | 712239682,737 | 18585,86 |
| 181 | South Africa | ZAF | 1996 | 38 | 8107058 | 8754 | 7708 | 1564 | 0,59 | 91680943222 | 123332496 | 66551396 | 19787716 | 484897960,736 | 7455,26 |
| 145 | Sudan | SDN | 1996 | -148 | 9279930 | -1127 | 2386 | 3543 | 5,18 | 45681269827 | 1483642 | -135157 | 956683 | 23443515,956 | 1409,82 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 1996 | 1275 | -295400 | 33942 | 28359 | 3761 | 0,02 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | FrenchGuiana | GUF | 1996 | 5254 | 0 | 2269 | 2157 | 4858 | 0,05 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | Mayotte | MYT | 1996 | -17 | 0 | 2177 | 2094 | 1171 | 1,74 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | NetherlandsAn-tilles | ANT | 1996 | -9 | 0 | 499 | 431 | 6324 | 27,76 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201 | FrenchPoly-nesia | PYF | 1996 | 7 | 18132 | 1732 | 1497 | -40 | -0,39 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | Martinique | MTQ | 1996 | 17 | 0 | 1963 | 1939 | 567 | 0,29 | 0 | 0 | 0 | 0 | 0 | 0 |
| 203 | UnitedStates-VirginIslands | VIR | 1996 | 1 | -2067 | 1420 | 1319 | 179 | 0,65 | 0 | 0 | 0 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 162 | Togo | TGO | 1996 | 181 | 1853960 | 5850 | 3521 | 4786 | 3,29 | 11229184198 | 12849014 | 4235828 | 2349117 | 57565109,729 | 1614,51 |
| 38 | Congo | COG | 1996 | 51 | 1242926 | 257 | 257 | 1510 | 0,6 | -1764449779 | 5064073 | 5143263 | 1686750 | 41333807,058 | 674,7 |
| 44 | Cayman Islands | CYM | 1996 | -27 | 9050 | 0 | 0 | 0 | 0 | 1118760046 | 0 | 0 | 0 | 0 | 0 |
| 105 | China, Macao SAR | MAC | 1996 | -2 | 111035 | 0 | 0 | 0 | 0 | 10142502134 | 0 | 0 | 0 | 0 | 0 |
| 120 | Mauritius | MUS | 1996 | 5 | 24196 | 0 | 0 | 0 | 0 | 9110622140 | 0 | 0 | 0 | 0 | 0 |
| 206 | Palau | PLW | 1996 | -15 | -568 | 457 | 480 | 251 | 0,04 | 0 | 0 | 0 | 0 | 0 | 0 |
| 199 | Samoa | WSM | 1996 | -9 | 20257 | 199 | 273 | 2507 | 10,87 | 0 | 0 | 0 | 0 | 0 | 0 |
| 194 | MicronesiaFed-eratedStatesof | FSM | 1996 | -286 | 4518 | 2555 | 2296 | 283 | 0,03 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | Guadeloupe | GLP | 1996 | -16 | 0 | 1294 | 1297 | 532 | 0,16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 197 | Eritrea | ERI | 1996 | -68 | 408141 | -4552 | -4610 | 6838 | 0,95 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Antigua and Barbuda | ATG | 1996 | 28 | 9922 | 466 | 337 | 112 | 0,12 | 432773259 | 42649234 | 15374692 | 9676257 | 237116668,081 | 10966,49 |
| 72 | Guyana | GUY | 1996 | -1687 | 37090 | 19662 | 13062 | 4287 | 0,14 | 2826906791 | 175171093 | 26311221 | 10561164 | 258801313,229 | 272,97 |
| 14 | Benin | BEN | 1996 | 228 | 2917999 | 49452 | 37934 | 7303 | 2,45 | 25379818143 | 143863991 | 58223346 | 6387482 | 156525240,004 | 2138,85 |
| 148 | Sierra Leone | SLE | 1996 | -7593 | 1560646 | 12627 | 9426 | 3317 | 0,02 | 5565348019 | 11197987 | 5836878 | 2326122 | 57001617,277 | 13,78 |
| 35 | Côte d'Ivoire | CIV | 1996 | -420 | 5830908 | 62014 | 61669 | 29885 | 4,65 | 82601866585 | 205911340 | 79879626 | 9180901 | 224977969,798 | 1453,83 |
| 42 | Costa Rica | CRI | 1996 | -1462 | 518303 | 2131 | 1699 | 1233 | 0,03 | 30758202124 | 64336862 | 18694695 | 10449695 | 256069765,496 | 288,05 |
| 27 | Brunei Darus-salam | BRN | 1996 | 125 | 48961 | 2177 | 2498 | 616 | 0,04 | 1432427403 | 334121026 | 23452381 | 6513378 | 159610321,358 | 347,71 |
| 90 | Kenya | KEN | 1996 | -14 | 11724705 | 11635 | 8631 | 22253 | 0,4 | 131145646279 | 37422537 | 8995174 | 18941416 | 464159380,085 | 336,72 |
| 166 | Trinidad and Tobago | TTO | 1996 | -226 | 71956 | 2119 | 2314 | 152 | 0,01 | -3082882142 | 45771378 | 14395199 | 6305179 | 154508405,072 | 565,65 |
| 131 | Oman | OMN | 1996 | 76 | 2079065 | 10405 | 4254 | 9396 | 21,01 | 31044778274 | 294733419 | 22144545 | 26670439 | 653559080,949 | 66804,18 |
| 133 | Panama | PAN | 1996 | -3432 | 673322 | 6805 | 6644 | 1732 | 0,01 | 61769151263 | 373594512 | 19980536 | 8254347 | 202272764,957 | 54,93 |
| 158 | Seychelles | SYC | 1996 | 0 | 7118 | 1459 | 1270 | 503 | 2,21 | 965053526 | 117178894 | -10953671 | 8541842 | 209317829,644 | 37629,26 |
| 186 | Cuba | CUB | 1996 | -7869 | 10281 | 24599 | 22371 | 3796 | 0,01 | 98064910475 | 497387844 | 442582251 | 111776625 | 2739086083,530 | 329,42 |
| 135 | Philippines | PHL | 1996 | 4773 | 15615056 | 354007 | 317085 | 77692 | 0,27 | 514020777480 | 3518674721 | 710449492 | 100240063 | 2456382643,289 | 333,01 |
| 86 | Jamaica | JAM | 1996 | -854 | 151251 | 3359 | 2376 | -478 | -0,02 | 2583450960 | 98114856 | 48902479 | -7576223 | -185655337,017 | -393,7 |
| 125 | Nigeria | NGA | 1996 | -8320 | 47549318 | 113985 | 77329 | 55581 | 0,07 | 321181345449 | 597092467 | 118560438 | 58950903 | 1444591818,896 | 66,79 |
| 88 | Japan | JPN | 1996 | 14 | -2023943 | 21228 | 18723 | 1482 | 1,45 | 483305980456 | 4294237225 | 668811273 | 374648929 | 9180771629,429 | 368236,48 |
| 53 | Ecuador | ECU | 1996 | 2792 | 2651849 | 27173 | 22826 | 8718 | 0,05 | 45024142640 | 629969829 | 105876865 | 103919692 | 2546551948,244 | 633,98 |
| 5 | United Arab Emirates | ARE | 1996 | -324 | 1360111 | 90785 | 36182 | 38948 | 5,68 | 191421507855 | 9780359642 | 49163209 | 9832599 | 240947828,634 | 3025,54 |
| 193 | TimorLeste | TLS | 1996 | -3 | 211509 | 1315 | 1014 | 2176 | 1,62 | -9346888325 | -8045657 | -7190238 | -6152689 | -150771637,775 | -4545,16 |
| 174 | United States | USA | 1996 | -1585 | 22022094 | 223674 | 187930 | 27348 | 0,12 | 4513943769222 | 49782214204 | 12940604267 | 1234450560 | 30250209734,834 | 5367,13 |
| 163 | Thailand | THA | 1996 | 6032 | 2627683 | 121871 | 69404 | 15125 | 0,06 | 359440435300 | 2575672371 | 543362574 | 123213932 | 3019357280,095 | 457,33 |

**TABLE A6**: PERCENTAGE CHANGES IN FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES BETWEEN 1996-2010

| 1996 vs 2010 (PERCENTAGE) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 140 | Qatar | QAT | 1996 | 0,002 | 2,553 | 3,064 | 2,931 | 3,028 | 3,061 | 4,519 | 5,885 | 1,033 | 0,489 | 0,489 | 0,485 |
| 5 | United Arab Emirates | ARE | 1996 | 0,017 | 2,367 | 1,706 | 1,730 | 0,914 | 0,882 | 0,891 | 0,406 | -0,117 | -0,084 | -0,084 | -0,099 |
| 160 | Turks and Caicos Islands | TCA | 1996 | -0,398 | 0,930 | 1,154 | 1,318 | -0,373 | 0 | 1,246 | 5,616 | 5,769 | 1,397 | 1,397 | 2,979 |
| 68 | Equatorial Guinea | GNQ | 1996 | 0,005 | 0,829 | 0,341 | 0,327 | 0,686 | 0 | 12,077 | 13,980 | -0,140 | 2,469 | 2,469 | 2,450 |
| 98 | Liberia | LBR | 1996 | 0,003 | 0,801 | 0,630 | 0,677 | 0,7 | 0,625 | 5,614 | 0,103 | 0,140 | 0,143 | 0,143 | 0,140 |
| 44 | Cayman Islands | CYM | 1996 | -0,048 | 0,664 | 0 | 0 | 0 | 0 | 0,562 | 0 | 0 | 0 | 0 | 0 |
| 2 | Angola | AGO | 1996 | -0,016 | 0,622 | 4,232 | 4,577 | 2,591 | 2 | 1,748 | 3,797 | 2,074 | 2,305 | 2,305 | 2,357 |
| 184 | Somalia | SOM | 1996 | -0,019 | 0,609 | 0,151 | 0,146 | 5,067 | 6,5 | 0,193 | -0,147 | -0,151 | 3,497 | 3,497 | 3,587 |
| 189 | PapuaNewGuinea | PNG | 1996 | -0,001 | 0,585 | 0,102 | 0,132 | 0,120 | 0 | 1,551 | 0,774 | 0,823 | 0,803 | 0,803 | 0,805 |
| 66 | Gambia | GMB | 1996 | 0,014 | 0,540 | -0,270 | -0,5 | -0,122 | 0 | 0,683 | 0,063 | -0,254 | 0,226 | 0,226 | 0,211 |
| 38 | Congo | COG | 1996 | -0,013 | 0,534 | 0,624 | 0,624 | 0 | 0 | 0,780 | 0,758 | -0,009 | 0 | 0 | 0 |
| 108 | Madagascar | MDG | 1996 | -0,026 | 0,521 | 0,652 | 0,646 | 0,761 | 1 | 0,521 | 0,813 | 0,630 | 0,461 | 0,461 | 0,500 |
| 14 | Benin | BEN | 1996 | -0,102 | 0,509 | 0,374 | 0,394 | 0,012 | 0,2 | 0,792 | 0,265 | 0,266 | -0,177 | -0,177 | -0,083 |
| 22 | Belize | BLZ | 1996 | -0,058 | 0,509 | 0,789 | 0,760 | 0,474 | 0,6 | 0,903 | 1,029 | 0,676 | 0,176 | 0,176 | 0,248 |
| 180 | Yemen | YEM | 1996 | -0,165 | 0,497 | 0,551 | 0,557 | 0,5 | 1 | 0,945 | 1,666 | 1,199 | 0,085 | 0,085 | 0,300 |
| 148 | Sierra Leone | SLE | 1996 | -0,011 | 0,488 | 0,167 | 0,423 | 0,013 | 0 | 0,829 | -0,133 | 0,012 | -0,222 | -0,222 | -0,214 |
| 162 | Togo | TGO | 1996 | 0,029 | 0,477 | -0,009 | 0,019 | 0 | 0 | 0,285 | -0,175 | -0,149 | 0 | 0 | 0 |
| 117 | Mozambique | MOZ | 1996 | -0,035 | 0,474 | 0,282 | 0,234 | 0,128 | 0,286 | 1,992 | 1,541 | 1,437 | 1,129 | 1,129 | 1,205 |
| 118 | Mauritania | MRT | 1996 | -0,070 | 0,473 | 0,166 | 0,166 | 0,220 | 0,310 | 0,427 | 0,685 | 0,727 | 0,735 | 0,735 | 0,866 |
| 90 | Kenya | KEN | 1996 | -0,014 | 0,470 | 0,715 | 0,862 | 0,017 | 0 | 0,632 | 0,831 | 1,018 | -0,134 | -0,134 | -0,121 |
| 61 | Gabon | GAB | 1996 | 0,000 | 0,459 | 0,067 | 0,156 | 0,216 | 0 | 0,072 | -0,090 | -0,071 | 0,117 | 0,117 | 0,117 |
| 36 | Cameroon | CMR | 1996 | 0,005 | 0,456 | 0,517 | 0,410 | 0,987 | 1 | 0,747 | 0,629 | 0,487 | 0,047 | 0,047 | 0,041 |
| 170 | U.R. of Tanzania: Mainland | TZA | 1996 | -0,023 | 0,454 | 0,613 | 0,722 | 0,114 | 0,167 | 1,226 | 1,805 | 1,977 | 0,772 | 0,772 | 0,813 |
| 144 | Saudi Arabia | SAU | 1996 | -0,101 | 0,441 | 0,508 | 0,500 | 0,417 | 0,568 | 0,473 | 0,992 | 0,497 | 0,126 | 0,126 | 0,253 |
| 125 | Nigeria | NGA | 1996 | -0,027 | 0,432 | 0,572 | 0,606 | 0,250 | 0,333 | 1,395 | 0,348 | 0,257 | -0,251 | -0,251 | -0,230 |
| 146 | Senegal | SEN | 1996 | 0,006 | 0,422 | 0,574 | 0,566 | 0,604 | 0,667 | 0,790 | 0,877 | 0,098 | 0,938 | 0,938 | 0,926 |
| 64 | Ghana | GHA | 1996 | -0,037 | 0,419 | 0,230 | 0,235 | 0,208 | 0,242 | 1,062 | 0,380 | 0,388 | 0,362 | 0,362 | 0,413 |
| 74 | Honduras | HND | 1996 | 0,028 | 0,416 | 0,718 | 0,887 | 0,133 | 0 | 0,680 | 1,124 | 1,333 | 0,404 | 0,404 | 0,366 |
| 147 | Singapore | SGP | 1996 | -0,035 | 0,410 | 1,361 | 1,794 | 0,732 | 1 | 1,148 | 2,191 | -0,900 | 0,475 | 0,475 | 0,528 |
| 132 | Pakistan | PAK | 1996 | -0,138 | 0,409 | 0,673 | 0,648 | 0,150 | 0,32 | 0,690 | 0,845 | 0,022 | 0,083 | 0,083 | 0,257 |
| 195 | Vanuatu | VUT | 1996 | 0,010 | 0,405 | -0,094 | -0,099 | -0,095 | 0 | 2,101 | 0,100 | 0,989 | 0,997 | 0,997 | 0,977 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Côte d'Ivoire | CIV | 1996 | -0,004 | 0,400 | 0,323 | 0,383 | 0,052 | 0,054 | 0,306 | 0,148 | 0,199 | -0,106 | -0,106 | -0,102 |
| 188 | SolomonIslands | SLB | 1996 | 0,003 | 0,400 | 0,454 | 0,360 | 0,805 | 0,5 | 1,975 | 2,089 | 1,891 | 2,836 | 2,836 | 2,824 |
| 145 | Sudan | SDN | 1996 | -0,441 | 0,394 | 0,410 | 1,019 | 1,1 | 2 | 1,317 | 8,184 | 5,937 | 0,458 | 0,458 | 1,608 |
| 197 | Eritrea | ERI | 1996 | -0,221 | 0,390 | 12,480 | 12,480 | -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | Guatemala | GTM | 1996 | -0,013 | 0,374 | 0,159 | 0,087 | 0,148 | 0 | 0,638 | 0,376 | 0,373 | 0,334 | 0,334 | 0,351 |
| 105 | China, Macao SAR | MAC | 1996 | -0,075 | 0,368 | 0 | 0 | 0 | 0 | 1,867 | 0 | 0 | 0 | 0 | 0 |
| 65 | Guinea | GIN | 1996 | -0,007 | 0,366 | 0,066 | -0,015 | 0,236 | 0 | 0,581 | 0,835 | 0,703 | 1,138 | 1,138 | 1,154 |
| 131 | Oman | OMN | 1996 | -0,353 | 0,360 | 0,774 | 0,791 | 0,503 | 1,325 | 0,538 | 1,598 | 0,359 | -0,363 | -0,363 | -0,014 |
| 122 | Malaysia | MYS | 1996 | -0,009 | 0,342 | 0,133 | 0,001 | 0,951 | 0,8 | 0,803 | 0,427 | 0,155 | 0,136 | 0,136 | 0,146 |
| 135 | Philippines | PHL | 1996 | -0,053 | 0,316 | 0,177 | 0,215 | 0,161 | 0,227 | 0,792 | 0,346 | 0,108 | -0,011 | -0,011 | 0,044 |
| 193 | TimorLeste | TLS | 1996 | -0,019 | 0,309 | 0,386 | 0,349 | -0,001 | 0,018 | -0,481 | -0,450 | -0,465 | -0,604 | -0,604 | -0,596 |
| 48 | Djibouti | DJI | 1996 | -0,307 | 0,305 | 0,628 | 0,610 | 0,294 | 0,778 | 1,021 | 3,396 | 3,248 | 3,215 | 3,215 | 5,081 |
| 187 | Kiribati | KIR | 1996 | 0 | 0,304 | -0,107 | -0,133 | 0,225 | 0,224 | 0,523 | 0,043 | 0,013 | 0,432 | 0,432 | 0,432 |
| 92 | Cambodia | KHM | 1996 | -0,074 | 0,303 | 0,100 | 0,140 | 0,106 | 0,208 | 1,915 | 1,324 | 1,492 | 1,201 | 1,201 | 1,376 |
| 133 | Panama | PAN | 1996 | 0,003 | 0,303 | 0,324 | 0,258 | 0,596 | 1 | 1,157 | 1,097 | -0,112 | -0,238 | -0,238 | -0,241 |
| 53 | Ecuador | ECU | 1996 | -0,064 | 0,283 | 0,294 | 0,934 | -0,026 | 0 | 0,553 | 0,290 | 0,302 | -0,290 | -0,290 | -0,242 |
| 27 | Brunei Darussalam | BRN | 1996 | 0,008 | 0,276 | 0,234 | 0,290 | 0,264 | 0,25 | 0,189 | 0,246 | 0,143 | -0,298 | -0,298 | -0,304 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 1996 | -0,011 | 0,270 | 0,367 | 0,349 | 0,346 | 0,25 | 0 | 0 | 0 | 0 | 0 | 0 |
| 190 | NewCaledonia | NCL | 1996 | -0,026 | 0,264 | 0,111 | 0,099 | 0,098 | 0 | 2,769 | 2,313 | 2,278 | 2,275 | 2,275 | 2,362 |
| 76 | Haiti | HTI | 1996 | -0,089 | 0,261 | 1,080 | 1,266 | -0,182 | -0,105 | 0,098 | 2,203 | 2,603 | 0,464 | 0,464 | 0,607 |
| 42 | Costa Rica | CRI | 1996 | 0,009 | 0,260 | 0,058 | 0,058 | 0,372 | 0,333 | 0,857 | 0,650 | 0,179 | -0,084 | -0,084 | -0,093 |
| 79 | India | IND | 1996 | -0,030 | 0,256 | 0,379 | 0,389 | 0,239 | 0,276 | 1,396 | 1,764 | 1,146 | 0,758 | 0,758 | 0,811 |
| 8 | Antigua and Barbuda | ATG | 1996 | -0,022 | 0,254 | -0,134 | -0,138 | -0,074 | -0,070 | 0,401 | 0,390 | 1,758 | -0,002 | -0,002 | 0,020 |
| 16 | Bangladesh | BGD | 1996 | 0,004 | 0,254 | 0,587 | 0,510 | -0,006 | -0,032 | 1,154 | 2,490 | 2,168 | 0,979 | 0,979 | 0,970 |
| 19 | Bahamas | BHS | 1996 | -0,138 | 0,250 | 0,400 | 0,419 | 0,185 | 0 | 0,330 | 1,179 | 1,019 | 0,635 | 0,635 | 0,897 |
| 126 | Nicaragua | NIC | 1996 | 0,030 | 0,228 | 0,305 | 0,333 | 0,231 | 0 | 0,604 | 0,444 | 0,418 | 0,270 | 0,270 | 0,233 |
| 110 | Mexico | MEX | 1996 | -0,057 | 0,225 | 0,328 | 0,427 | 0,164 | 0,333 | 0,400 | 0,647 | 0,509 | 0,187 | 0,187 | 0,259 |
| 39 | Colombia | COL | 1996 | -0,035 | 0,220 | 0,546 | 0,591 | 0,286 | 0,2 | 0,523 | 0,716 | 0,464 | 0,261 | 0,261 | 0,307 |
| 51 | Dominican Republic | DOM | 1996 | -0,025 | 0,219 | 0,425 | 0,439 | 0,152 | 0,167 | 1,100 | 1,771 | 0,841 | 0,586 | 0,586 | 0,626 |
| 9 | Australia | AUS | 1996 | -0,049 | 0,218 | 0,187 | 0,202 | 0,212 | 0,333 | 0,579 | 0,610 | 0,200 | 0,049 | 0,049 | 0,103 |
| 181 | South Africa | ZAF | 1996 | 0,019 | 0,212 | 0,146 | 0,142 | 0,182 | 0 | 0,546 | 0,302 | 0,292 | 0,332 | 0,332 | 0,306 |
| 201 | FrenchPolynesia | PYF | 1996 | -0,025 | 0,207 | 0,193 | 0,225 | 0,125 | 0,153 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78 | Indonesia | IDN | 1996 | -0,063 | 0,205 | 0,204 | 0,266 | 0,188 | 0,2 | 0,602 | 0,912 | 0,741 | 0,434 | 0,434 | 0,531 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | Brazil | BRA | 1996 | -0,018 | 0,189 | 0,002 | 0,002 | 0,912 | 1 | 0,543 | 0,184 | 0,128 | 0,251 | 0,251 | 0,274 |
| 152 | Suriname | SUR | 1996 | 0,041 | 0,181 | 1,156 | 1,673 | 0,219 | 0,188 | 0,744 | 2,069 | 2,878 | 0,475 | 0,475 | 0,416 |
| 158 | Seychelles | SYC | 1996 | 0 | 0,176 | 0,077 | 0,085 | 0,064 | 0,065 | 0,599 | 0,492 | 0,066 | -0,560 | -0,560 | -0,560 |
| 130 | New Zealand | NZL | 1996 | 0,040 | 0,176 | 0,165 | 0,177 | 0,039 | 0 | 0,469 | 0,529 | 0,397 | 0,079 | 0,079 | 0,038 |
| 134 | Peru | PER | 1996 | -0,166 | 0,173 | 0,328 | 0,309 | 0,282 | 0 | 0,901 | 0,966 | 0,710 | 0,908 | 0,908 | 1,287 |
| 99 | Saint Lucia | LCA | 1996 | -0,006 | 0,170 | -0,017 | -0,018 | 0,067 | 0,111 | 0,328 | 0,661 | 0,016 | 1,235 | 1,235 | 1,249 |
| 179 | Vietnam | VNM | 1996 | -0,057 | 0,156 | 0,154 | 0,143 | 0,230 | 0,305 | 1,470 | 3,019 | 2,613 | 2,776 | 2,776 | 3,007 |
| 174 | United States | USA | 1996 | -0,033 | 0,152 | 0,171 | 0,177 | 0,133 | 0,143 | 0,414 | 0,423 | 0,232 | -0,056 | -0,056 | -0,024 |
| 114 | Myanmar | MMR | 1996 | -0,075 | 0,138 | 0,371 | 0,392 | 0,131 | 0,231 | 3,356 | 6,617 | 2,791 | 2,347 | 2,347 | 2,618 |
| 163 | Thailand | THA | 1996 | -0,058 | 0,117 | 0,370 | 2,021 | -0,718 | -0,727 | 0,537 | 0,509 | 1,252 | -0,533 | -0,533 | -0,504 |
| 100 | Sri Lanka | LKA | 1996 | -0,306 | 0,103 | 0,127 | 0,110 | 0,082 | 0,545 | 1,044 | 0,916 | 0,337 | 0,759 | 0,759 | 1,536 |
| 199 | Samoa | WSM | 1996 | 0,026 | 0,102 | -0,181 | -0,091 | -0,299 | -0,324 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86 | Jamaica | JAM | 1996 | 0,007 | 0,098 | 0,004 | 0,104 | -0,291 | -0,295 | 0,049 | 0,104 | 0,292 | -0,137 | -0,137 | -0,143 |
| 59 | Fiji | FJI | 1996 | 0,005 | 0,096 | -0,264 | -0,302 | 0,270 | 0,333 | 0,237 | -0,074 | -0,020 | 0,435 | 0,435 | 0,428 |
| 34 | China | CHN | 1996 | -0,161 | 0,094 | 0,332 | 0,336 | 0,135 | 0,353 | 1,795 | 4,113 | 1,817 | 1,580 | 1,580 | 2,075 |
| 120 | Mauritius | MUS | 1996 | -0,293 | 0,093 | 0 | 0 | 0 | 0 | 0,855 | 0 | 0 | 0 | 0 | 0 |
| 149 | El Salvador | SLV | 1996 | 0,014 | 0,087 | -0,109 | -0,155 | 0,102 | 0 | 0,377 | 0,378 | 0,350 | 0,502 | 0,502 | 0,481 |
| 169 | Taiwan | TWN | 1996 | 0,076 | 0,079 | -0,061 | -0,076 | 0,623 | 0,508 | 0,893 | 0,611 | 0,252 | 0,901 | 0,901 | 0,766 |
| 202 | Tonga | TON | 1996 | 0,015 | 0,072 | 0,838 | 3,170 | -0,252 | -0,256 | 0,911 | 2,277 | 6,434 | 0,333 | 0,333 | 0,313 |
| 166 | Trinidad and Tobago | TTO | 1996 | -0,040 | 0,056 | 0,720 | 0,777 | -0,476 | -0,429 | 1,402 | 1,153 | 0,166 | -0,750 | -0,750 | -0,739 |
| 70 | Grenada | GRD | 1996 | -0,005 | 0,052 | -0,25 | -0,25 | 0,111 | 0,25 | 0,570 | 0,417 | 0,447 | 0,671 | 0,671 | 0,679 |
| 206 | Palau | PLW | 1996 | 0,008 | 0,046 | 0,195 | 0,333 | -0,833 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 186 | Cuba | CUB | 1996 | -0,075 | 0,030 | 0,114 | 0,067 | 0,062 | 1 | -0,081 | -0,006 | -0,047 | -0,052 | -0,052 | 0,026 |
| 88 | Japan | JPN | 1996 | -0,022 | 0,015 | 0,068 | 0,075 | -0,327 | -0,310 | 0,092 | 0,259 | 0,231 | -0,240 | -0,240 | -0,223 |
| 203 | UnitedStatesVirgin-Islands | VIR | 1996 | -0,028 | 0,002 | -0,022 | -0,073 | 0,013 | 0,074 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185 | PuertoRico | PRI | 1996 | 0,009 | -0,001 | 0,227 | 0,364 | -0,194 | -0,198 | 1,533 | 2,111 | 2,458 | 1,044 | 1,044 | 1,026 |
| 72 | Guyana | GUY | 1996 | 0,031 | -0,015 | 0,235 | 0,188 | -0,186 | -0,207 | 1,217 | 0,391 | 0,391 | -0,127 | -0,127 | -0,153 |
| 194 | MicronesiaFeder-atedStatesof | FSM | 1996 | -0,010 | -0,029 | -0,238 | -0,241 | -0,354 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | FrenchGuiana | GUF | 1996 | 0,024 | 0 | 0,377 | 0,361 | 0,848 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | Mayotte | MYT | 1996 | 0,022 | 0 | 0,722 | 0,698 | 0,402 | 0,412 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | NetherlandsAntilles | ANT | 1996 | -0,188 | 0 | 0,688 | 0,688 | 0,469 | 0,794 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | Martinique | MTQ | 1996 | 0,003 | 0 | -0,007 | -0,002 | 0,262 | 0,5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | Guadeloupe | GLP | 1996 | 0,005 | 0 | 0,077 | 0,233 | -0,387 | -0,391 | 0 | 0 | 0 | 0 | 0 | 0 |

**TABLE A7**: PERCENTAGE CHANGES IN FLOOD RISK AND FLOOD REDUCTION BENEFITS OF MANGROVES ACROSS 97 COUNTRIES BETWEEN 2010-2020

| 2010 vs 2020 (PERCENTAGE) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | COUNTRY | ISO3 | YEAR | MANG HA | POP | POP EXP | POP RISK | POP BEN | POP BEN HA | STOCK | STOCK EXP | STOCK RISK | STOCK BEN | PV 100yr 4% | STOCK BEN HA |
| 179 | Vietnam | VNM | 1996 | -0,006 | 0,107 | 0,729 | 0,588 | 0,493 | 0,502 | 0,846 | 1,692 | 1,307 | 1,258 | 1,258 | 1,272 |
| 34 | China | CHN | 1996 | 0,022 | 0,052 | 0,182 | 0,135 | 0,573 | 0,539 | 0,527 | 1,491 | 0,870 | 2,176 | 2,176 | 2,107 |
| 185 | PuertoRico | PRI | 1996 | -0,049 | -0,118 | 0,584 | 0,533 | 0,153 | 0,207 | -0,020 | 0,761 | 0,704 | 0,281 | 0,281 | 0,347 |
| 79 | India | IND | 1996 | -0,005 | 0,118 | 0,933 | 0,879 | 0,477 | 0,478 | 0,827 | 1,969 | 1,363 | 1,170 | 1,170 | 1,181 |
| 78 | Indonesia | IDN | 1996 | -0,010 | 0,131 | 0,828 | 0,797 | 0,344 | 0,417 | 0,671 | 1,608 | 1,331 | 0,887 | 0,887 | 0,905 |
| 169 | Taiwan | TWN | 1996 | -0,212 | 0,020 | 1,233 | 1,094 | -0,151 | 0,078 | 0,319 | 1,565 | 1,157 | 0,066 | 0,066 | 0,353 |
| 152 | Suriname | SUR | 1996 | 0,006 | 0,109 | 0,619 | 0,683 | 1,171 | 1,158 | 0,074 | 0,787 | 0,492 | 0,696 | 0,696 | 0,686 |
| 16 | Bangladesh | BGD | 1996 | 0,003 | 0,116 | 2,052 | 2,192 | 2,862 | 2,9 | 0,959 | 4,463 | 4,131 | 6,417 | 6,417 | 6,394 |
| 110 | Mexico | MEX | 1996 | 0,002 | 0,130 | 1,544 | 1,512 | 1,142 | 1 | 0,234 | 1,878 | 1,394 | 1,338 | 1,338 | 1,334 |
| 190 | NewCaledonia | NCL | 1996 | 0,041 | 0,086 | 2,759 | 2,611 | 0,304 | 0,333 | 0,809 | 5,264 | 5,018 | 1,174 | 1,174 | 1,087 |
| 9 | Australia | AUS | 1996 | -0,012 | 0,151 | 2,497 | 2,426 | 1,849 | 1,75 | 0,228 | 2,822 | 2,346 | 1,986 | 1,986 | 2,021 |
| 25 | Brazil | BRA | 1996 | 0,010 | 0,086 | 1,138 | 1,080 | 0,950 | 0,917 | 0,075 | 1,399 | 1,173 | 1,039 | 1,039 | 1,019 |
| 92 | Cambodia | KHM | 1996 | 0,020 | 0,168 | 0,314 | 0,266 | 0,816 | 0,776 | 0,980 | 1,135 | 1,080 | 1,438 | 1,438 | 1,391 |
| 64 | Ghana | GHA | 1996 | 0,024 | 0,254 | 1,217 | 0,798 | 0,246 | 0,220 | 0,888 | 1,148 | 0,893 | 0,636 | 0,636 | 0,598 |
| 19 | Bahamas | BHS | 1996 | 0,027 | 0,108 | 0,743 | 0,693 | 1,896 | 1 | 0,129 | 0,912 | 0,907 | 2,390 | 2,390 | 2,301 |
| 122 | Malaysia | MYS | 1996 | -0,009 | 0,148 | 0,901 | 1,198 | -0,575 | -0,556 | 0,629 | 1,574 | 1,061 | 0,015 | 0,015 | 0,024 |
| 114 | Myanmar | MMR | 1996 | -0,010 | 0,075 | 0,625 | 0,702 | -0,268 | -0,25 | 0,806 | 4,195 | 2,906 | 3,863 | 3,863 | 3,912 |
| 146 | Senegal | SEN | 1996 | -0,008 | 0,320 | 0,839 | 0,767 | 1,885 | 1,8 | 0,633 | 1,202 | 1,200 | 1,240 | 1,240 | 1,259 |
| 39 | Colombia | COL | 1996 | 0,003 | 0,128 | 1,615 | 1,498 | -0,186 | -0,167 | 0,422 | 2,340 | 1,251 | 0,609 | 0,609 | 0,604 |
| 189 | PapuaNewGuinea | PNG | 1996 | -0,013 | 0,286 | 4,525 | 6,491 | 1,081 | 1 | 0,639 | 6,043 | 8,550 | 1,653 | 1,653 | 1,688 |
| 76 | Haiti | HTI | 1996 | -0,014 | 0,146 | 1,378 | 1,409 | 2,328 | 2,373 | 0,204 | 1,870 | 2,399 | 3,243 | 3,243 | 3,306 |
| 100 | Sri Lanka | LKA | 1996 | 0,010 | 0,057 | 7,088 | 10,755 | 0,285 | 0,294 | 0,576 | 11,800 | 13,602 | 0,662 | 0,662 | 0,645 |
| 2 | Angola | AGO | 1996 | -0,011 | 0,406 | 4,019 | 4,769 | 3,566 | 3,333 | 0,153 | 3,993 | 2,504 | 3,576 | 3,576 | 3,628 |
| 118 | Mauritania | MRT | 1996 | 0,150 | 0,330 | 1,109 | 1,237 | 0,136 | -0,012 | 0,491 | 2,421 | 1,939 | 1,503 | 1,503 | 1,176 |
| 160 | Turks and Caicos Islands | TCA | 1996 | 0,210 | 0,185 | 1,076 | 1,027 | 17,438 | 10 | 0,521 | 0,959 | 1,416 | 11,217 | 11,217 | 9,098 |
| 65 | Guinea | GIN | 1996 | -0,026 | 0,288 | 2,903 | 2,609 | 1,334 | 1,667 | 0,808 | 6,094 | 5,406 | 4,680 | 4,680 | 4,832 |
| 130 | New Zealand | NZL | 1996 | -0,017 | 0,104 | 7,934 | 8,951 | 0,466 | 0,333 | 0,345 | 9,124 | 8,088 | 3,947 | 3,947 | 4,033 |
| 117 | Mozambique | MOZ | 1996 | -0,031 | 0,327 | 1,000 | 0,807 | 0,049 | 0 | 0,646 | 4,365 | 4,576 | 2,388 | 2,388 | 2,495 |
| 22 | Belize | BLZ | 1996 | 0,007 | 0,233 | 1,523 | 1,503 | 0,079 | 0,125 | 0,179 | 1,734 | 1,591 | -0,071 | -0,071 | -0,077 |
| 108 | Madagascar | MDG | 1996 | 0,002 | 0,308 | 0,832 | 0,825 | 0,170 | 0,167 | 0,385 | 0,669 | 0,112 | 0,374 | 0,374 | 0,371 |
| 170 | U.R. of Tanzania: Mainland | TZA | 1996 | -0,012 | 0,346 | 1,870 | 2,139 | 0,345 | 0,286 | 0,909 | 3,632 | 4,147 | 1,225 | 1,225 | 1,251 |
| 144 | Saudi Arabia | SAU | 1996 | -0,245 | 0,270 | 1,558 | 1,374 | 2,109 | 3,130 | 0,337 | 2,243 | 1,519 | 3,870 | 3,870 | 5,448 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | Dominican Republic | DOM | 1996 | -0,006 | 0,119 | 2,161 | 2,389 | 4,065 | 3,857 | 0,672 | 3,355 | 2,562 | 1,218 | 1,218 | 1,232 |
| 74 | Honduras | HND | 1996 | -0,080 | 0,191 | 2,361 | 2,258 | 0,344 | 0,5 | 0,415 | 2,568 | 2,630 | 0,203 | 0,203 | 0,307 |
| 59 | Fiji | FJI | 1996 | 0,001 | 0,043 | 3,647 | 3,933 | 1,157 | 1 | 0,342 | 4,924 | 5,638 | 1,674 | 1,674 | 1,671 |
| 188 | SolomonIslands | SLB | 1996 | -0,007 | 0,279 | 1,046 | 1,221 | 2,350 | 2 | 1,383 | 2,812 | 3,139 | 5,242 | 5,242 | 5,284 |
| 140 | Qatar | QAT | 1996 | 0,060 | 0,553 | 7,600 | 6,685 | 10,264 | 9,597 | 0,397 | 11,301 | 7,835 | 11,563 | 11,563 | 10,853 |
| 132 | Pakistan | PAK | 1996 | -0,110 | 0,231 | 0,760 | 0,840 | -0,297 | -0,212 | 0,531 | 0,700 | 0,479 | -0,053 | -0,053 | 0,065 |
| 202 | Tonga | TON | 1996 | -0,030 | -0,020 | 3,770 | 3,054 | 3,117 | 3,219 | 0,432 | 5,968 | 4,922 | 5,014 | 5,014 | 5,200 |
| 147 | Singapore | SGP | 1996 | -0,070 | 0,140 | 4,270 | 4,016 | 2,760 | 3 | 0,409 | 5,442 | 23,779 | 1,145 | 1,145 | 1,306 |
| 149 | El Salvador | SLV | 1996 | -0,029 | 0,049 | 2,369 | 2,527 | 1,910 | 1 | 0,239 | 2,931 | 3,730 | 0,043 | 0,043 | 0,074 |
| 126 | Nicaragua | NIC | 1996 | -0,061 | 0,138 | 6,125 | 6,347 | 7,614 | 8 | 0,264 | 7,138 | 8,288 | 4,888 | 4,888 | 5,271 |
| 68 | Equatorial Guinea | GNQ | 1996 | -0,006 | 0,487 | 5,541 | 6,216 | 20,864 | 0 | -0,277 | 4,569 | 14,986 | 14,133 | 14,133 | 14,225 |
| 187 | Kiribati | KIR | 1996 | 0 | 0,171 | -0,302 | -0,389 | 1,099 | 1,103 | 0,346 | -0,197 | -0,298 | 1,413 | 1,413 | 1,413 |
| 36 | Cameroon | CMR | 1996 | -0,003 | 0,305 | 6,702 | 10,049 | 12,333 | 11,667 | 0,559 | 7,410 | 12,835 | 7,537 | 7,537 | 7,561 |
| 71 | Guatemala | GTM | 1996 | 0,009 | 0,225 | 6,085 | 6,484 | 1,621 | 2 | 0,422 | 6,018 | 4,614 | 1,922 | 1,922 | 1,897 |
| 184 | Somalia | SOM | 1996 | -0,013 | 0,375 | 0,118 | 0,018 | 1,256 | 1,333 | 0,116 | -0,093 | -0,174 | 0,830 | 0,830 | 0,854 |
| 99 | Saint Lucia | LCA | 1996 | 0 | 0,055 | 3,148 | 2,986 | 119,813 | 118,3 | 0,177 | 3,563 | 6,260 | 74,975 | 74,975 | 74,975 |
| 134 | Peru | PER | 1996 | 0,061 | 0,138 | 1,698 | 1,961 | 6,242 | 5 | 0,460 | 2,841 | 2,871 | 11,835 | 11,835 | 11,101 |
| 98 | Liberia | LBR | 1996 | -0,047 | 0,299 | 3,567 | 9,322 | 1,196 | 1,308 | 0,427 | 4,801 | 11,098 | 2,288 | 2,288 | 2,451 |
| 61 | Gabon | GAB | 1996 | -0,006 | 0,370 | 4,971 | 6,891 | 2,690 | 0 | 0,438 | 6,080 | 3,641 | 1,031 | 1,031 | 1,043 |
| 48 | Djibouti | DJI | 1996 | 0,124 | 0,176 | 0,330 | 0,632 | 58,518 | 51,5 | 1,347 | 1,529 | 0,227 | 8,279 | 8,279 | 7,255 |
| 70 | Grenada | GRD | 1996 | 0 | 0,059 | 537,667 | 530,333 | 61,3 | 58,6 | 0,367 | 475,880 | 696,148 | 88,658 | 88,658 | 88,658 |
| 66 | Gambia | GMB | 1996 | -0,010 | 0,347 | 6,894 | 396,714 | 2,013 | 1 | 0,316 | 5,993 | 263,529 | 2,370 | 2,370 | 2,402 |
| 195 | Vanuatu | VUT | 1996 | -0,043 | 0,270 | 6,208 | 5,749 | 83,579 | 104 | 0,567 | 7,897 | 7,331 | 103,396 | 103,396 | 108,097 |
| 180 | Yemen | YEM | 1996 | -0,065 | 0,288 | 1,535 | 1,413 | 188,061 | 198 | -0,558 | 1,339 | 2,268 | 46,842 | 46,842 | 50,172 |
| 181 | South Africa | ZAF | 1996 | 0,015 | 0,158 | 6,703 | 6,656 | 40,103 | 59 | 0,148 | 7,211 | 6,878 | 196,262 | 196,262 | 193,442 |
| 145 | Sudan | SDN | 1996 | -0,178 | 0,269 | -0,119 | 0,560 | 168,714 | 172,667 | 0,421 | 0,094 | -0,057 | 22,273 | 22,273 | 27,306 |
| 177 | Venezuela (Bolivarian Republic of) | VEN | 1996 | 0,004 | -0,010 | 0,308 | 0,282 | 0,234 | 0,4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | FrenchGuiana | GUF | 1996 | 0,067 | 0 | 1,648 | 1,625 | 3,995 | 2,5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | Mayotte | MYT | 1996 | -0,025 | 0 | 23,409 | 28,685 | 7,140 | 7,25 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | NetherlandsAntilles | ANT | 1996 | -0,038 | 0 | 18,481 | 15,963 | 43,917 | 45,508 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201 | FrenchPolynesia | PYF | 1996 | 0,059 | 0,064 | 4,522 | 5,848 | -0,247 | -0,287 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | Martinique | MTQ | 1996 | 0,009 | 0 | 4,305 | 4,357 | 10,698 | 9,667 | 0 | 0 | 0 | 0 | 0 | 0 |
| 203 | UnitedStatesVirgin-Islands | VIR | 1996 | 0,004 | -0,019 | 10,758 | 17,355 | 2,295 | 2,241 | 0 | 0 | 0 | 0 | 0 | 0 |
| 162 | Togo | TGO | 1996 | 0,142 | 0,289 | 2,474 | 2,425 | 0 | 0 | 1,315 | 3,033 | 2,519 | 0 | 0 | 0 |
| 38 | Congo | COG | 1996 | 0,021 | 0,291 | 0,345 | 0,345 | 0 | 0 | -0,098 | 0,822 | 2,346 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | Cayman Islands | CYM | 1996 | -0,006 | 0,160 | 0 | 0 | 0 | 0 | 0,292 | 0 | 0 | 0 | 0 | 0 |
| 105 | China, Macao SAR | MAC | 1996 | -0,016 | 0,206 | 0 | 0 | 0 | 0 | 0,193 | 0 | 0 | 0 | 0 | 0 |
| 120 | Mauritius | MUS | 1996 | 0,013 | 0,019 | 0 | 0 | 0 | 0 | 0,433 | 0 | 0 | 0 | 0 | 0 |
| 206 | Palau | PLW | 1996 | -0,003 | -0,031 | 4,394 | 4,615 | 125,5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 199 | Samoa | WSM | 1996 | -0,038 | 0,104 | 0,524 | 1,011 | 41,098 | 43,48 | 0 | 0 | 0 | 0 | 0 | 0 |
| 194 | MicronesiaFeder-atedStatesof | FSM | 1996 | -0,032 | 0,042 | 3,398 | 3,447 | 2,066 | 1,5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | Guadeloupe | GLP | 1996 | -0,005 | 0 | 0,879 | 0,972 | 1,099 | 1,143 | 0 | 0 | 0 | 0 | 0 | 0 |
| 197 | Eritrea | ERI | 1996 | -0,009 | 0,130 | -0,496 | -0,502 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Antigua and Bar-buda | ATG | 1996 | 0,033 | 0,113 | 0,609 | 0,473 | 0,329 | 0,3 | 0,348 | 0,845 | 0,671 | 2,201 | 2,201 | 2,098 |
| 72 | Guyana | GUY | 1996 | -0,042 | 0,049 | 0,367 | 0,299 | 0,146 | 0,192 | 0,463 | 0,416 | 208,265 | 127,634 | 127,634 | 133,156 |
| 14 | Benin | BEN | 1996 | 0,083 | 0,317 | 1,181 | 1,148 | 43,994 | 40,833 | 1,331 | 1,430 | 1,353 | 15,136 | 15,136 | 13,898 |
| 148 | Sierra Leone | SLE | 1996 | -0,042 | 0,243 | 3,154 | 6,972 | 0,992 | 1 | 0,558 | 4,177 | 10,623 | 1,791 | 1,791 | 1,914 |
| 35 | Côte d'Ivoire | CIV | 1996 | -0,061 | 0,284 | 2,435 | 2,995 | 11,222 | 11,923 | 1,472 | 3,382 | 4,792 | 2,796 | 2,796 | 3,043 |
| 42 | Costa Rica | CRI | 1996 | -0,038 | 0,113 | 0,763 | 0,630 | 0,824 | 0,75 | 0,389 | 1,176 | 1,058 | 1,823 | 1,823 | 1,935 |
| 27 | Brunei Darussalam | BRN | 1996 | 0,007 | 0,126 | 0,741 | 1,168 | 0,625 | 0,8 | 0,060 | 1,216 | 0,987 | 4,989 | 4,989 | 4,949 |
| 90 | Kenya | KEN | 1996 | -0,000 | 0,279 | 1,515 | 1,283 | 1,865 | 1,905 | 0,709 | 2,059 | 1,127 | 1,676 | 1,676 | 1,677 |
| 166 | Trinidad and Tobago | TTO | 1996 | -0,020 | 0,054 | 2,976 | 3,373 | 0,366 | 0,25 | -0,072 | 8,673 | 7,362 | 9,975 | 9,975 | 10,197 |
| 131 | Oman | OMN | 1996 | 0,244 | 0,684 | 0,256 | 0,126 | 1,812 | 1,260 | 0,307 | 0,229 | 0,206 | 7,975 | 7,975 | 6,213 |
| 133 | Panama | PAN | 1996 | -0,022 | 0,185 | 2,626 | 3,030 | 0,575 | 0,5 | 0,767 | 6,290 | 2,101 | 1,277 | 1,277 | 1,328 |
| 158 | Seychelles | SYC | 1996 | 0 | 0,078 | 0,349 | 0,316 | 3,376 | 3,348 | 0,574 | 0,560 | -0,303 | 4,925 | 4,925 | 4,925 |
| 186 | Cuba | CUB | 1996 | -0,022 | 0,001 | 2,728 | 3,162 | 0,699 | 0,5 | 1,038 | 6,589 | 7,472 | 2,459 | 2,459 | 2,538 |
| 135 | Philippines | PHL | 1996 | 0,018 | 0,166 | 0,624 | 0,633 | 0,311 | 0,293 | 0,806 | 1,129 | 0,810 | 0,204 | 0,204 | 0,183 |
| 86 | Jamaica | JAM | 1996 | -0,080 | 0,054 | 0,383 | 0,312 | -0,146 | -0,065 | 0,097 | 0,401 | 0,450 | -0,163 | -0,163 | -0,090 |
| 125 | Nigeria | NGA | 1996 | -0,009 | 0,300 | 1,305 | 1,371 | 1,411 | 1,75 | 0,348 | 1,626 | 1,314 | 1,709 | 1,709 | 1,734 |
| 88 | Japan | JPN | 1996 | 0,014 | -0,016 | 1,287 | 1,295 | 1,478 | 1,45 | 0,097 | 1,410 | 1,000 | 10,054 | 10,054 | 9,901 |
| 53 | Ecuador | ECU | 1996 | 0,017 | 0,177 | 3,126 | 2,971 | 1,135 | 1 | 0,274 | 3,729 | 2,889 | 2,530 | 2,530 | 2,470 |
| 5 | United Arab Emirates | ARE | 1996 | -0,042 | 0,159 | 0,391 | 0,169 | 0,534 | 0,601 | 0,420 | 0,545 | 0,109 | 0,033 | 0,033 | 0,078 |
| 193 | TimorLeste | TLS | 1996 | -0,002 | 0,194 | 0,949 | 0,864 | 1,430 | 1,434 | -0,662 | -0,448 | -0,472 | -0,311 | -0,311 | -0,310 |
| 174 | United States | USA | 1996 | -0,007 | 0,071 | 1,446 | 1,330 | 0,741 | 0,75 | 0,250 | 1,531 | 1,443 | 1,027 | 1,027 | 1,041 |
| 163 | Thailand | THA | 1996 | 0,023 | 0,039 | 1,635 | 1,255 | 1,775 | 2 | 0,356 | 2,104 | 1,830 | 1,398 | 1,398 | 1,343 |

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