

# WHITE PAPER SERIES



# The Blue Carbon Mangrove Forests

By Anita Tang July 10, 2022

Tropical forest restoration is one of the top solutions to reverse climate change. However, we cannot rely only on land-based forestation projects to achieve our climate goal but also must employ marine-based forestation projects. According to the United Nations Educational, Scientific and Cultural Organization, blue-carbon assets are among the Earth's most efficient absorbers and long-term repositories of carbon. In addition, coastal ecosystems such as mangroves, tidal marshes and seagrasses are unique in their ability to sequester carbon, mitigate climate risk, improve livelihoods, and safeguard biodiversity.

In my previous blue-carbon paper, titled "Understanding Blue Carbon," I included basic information about blue carbon. In this paper, as a follow-through, I am taking a closer look at mangrove forests, currently a big kind of contributor to blue carbon.

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# I. Mangrove Forests for Blue Carbon Credits

Mangrove forests cover just 0.1 percent of the planet's surface but store up to 10 times more carbon per hectare than terrestrial forests, and are able to store the carbon for 3-5x longer<sup>1</sup>. Managing this carbon-storing superpower can make mangroves a critical part of the solution to climate change.

Mangrove restoration is the best studied and most advanced kind of blue carboncredit project to date. An assessment by "Global Potential and Limits of Mangrove Blue Carbon for Climate Change Mitigation" released in April 2021, concluded that about 20 percent of the world's mangrove forests can qualify for blue-carbon financing, and above half of which can be financially sustainable over a 30-year timeframe based on carbon prices of US\$5-9.4 t<sup>-1</sup>CO<sub>2</sub>e<sup>2</sup>.

Mangroves are trees (about 70 percent underwater, 30 percent above water) that have evolved to be able to survive in flooded coastal environments where seawater meets freshwater and the resulting lack of oxygen makes life impossible for other plants.<sup>3</sup>

With 50 to maybe up to 110 mangrove species, they are the only species of trees in the world that can tolerate saltwater. Mangroves, specifically the underwater habitat their roots provide, offer critical nursing environments for juveniles of thousands of fish species, from 1-inch gobies to 10-foot sharks. Mangroves' dense root systems inhibit the flow of tidal water and encourage the deposition of nutrient-rich sediments. But once lost, mangroves are very difficult to replant due to shifts in the very sediments the roots helped keep in place; therefore, it is a lot more beneficial to revitalize mangrove than replanting them.<sup>4</sup>

<sup>2</sup> "Global Potential and Limits of Mangrove Blue Carbon for Climate Change Mitigation," Yiwen Zeng, Daniel A. Friess,

https://carboncredits.com/the-importance-of-blue-carbon-credits

<sup>&</sup>lt;sup>1</sup> "Blue Carbon Credits Emerge as Potential New Market for Global Sustainability," Haley Toadvine, Earth.org, June 11, 2021. Retrieved on July 5, 2022, <u>https://earth.org/blue-carbon-credit</u>

Tasya Vadya Sarira, Kelly Siman and Lian Pin Koh, Science Direct, April 26, 2021, Pages 1737-1743.e3. Retrieved on July 6, 2022, <u>https://www.sciencedirect.com/science/article/pii/S0960982221001354#</u>

<sup>&</sup>lt;sup>3</sup> "The Importance of Blue Carbon Credits," Carboncredits.com. Retrieved on July 5, 2022,

<sup>&</sup>lt;sup>4</sup> "Mangroves: 11 Facts You Need to Know," Conservation International. Retrieved on July 5, 2022, <u>https://www.conservation.org/stories/11-facts-you-need-to-know-about-mangroves</u>

Figure 1: Mangroves vs. Terrestrial Forests



Source: World Economic Forum (Image by Conservation International), https://www.weforum.org/agenda/2021/07/why-the-future-of-carbon-should-be-blue

Mangroves have been estimated to prevent more than US\$65 billion in property damages and reduce flood risk to some 15 million people every year, with overall ecosystem service benefits estimated to fall between US\$462 billion and US\$798 billion per year. In fact, economic analysis shows that the benefits of mangrove restoration and conservation could outweigh the costs by 3:1.<sup>5</sup>

<sup>&</sup>lt;sup>5</sup> "What are Blue Carbon Credits and How to Maximize Their Impact," Whitney Johnston, World Economic Forum, September 21, 2021. Retrieved on July 5, 2022, <u>https://www.weforum.org/agenda/2021/09/how-to-maximise-blue-carbon-credits</u>

Figure 2: Distribution of World Mangroves



Source: Slideshare, <u>https://image.slidesharecdn.com/mangroves-150526170015-lva1-app6891/95/mangroves-6-638.jpg?cb=1432660092</u>

# II. Mangrove Forests Threatened by Deforestation

Mangroves have been threatened by deforestation for decades, as agriculture and aquaculture, urban development and harvesting have caused the loss of more than a quarter of mangrove forests in the past 50 years<sup>6</sup>. The global economic calculus that made mangroves more valuable dead than alive has devastated them – nearly half the world's mangroves have been lost in just the past century as they were cleared for fish farms, development, and firewood<sup>7</sup>.

It is estimated that over 1 billion tons of  $CO_2$  is released annually from degrading coastal ecosystems. There are around 14 million hectares of mangrove aqua-forests on Earth today, many are under attack by the deforestation practices caused by intense shrimp farming.<sup>8</sup>

<sup>6</sup> "NASA Study Maps the Roots of Global Mangrove Loss," NASA, August 18, 2020. Retrieved on July 5, 2022, <u>https://www.nasa.gov/feature/goddard/2020/nasa-study-maps-the-roots-of-global-mangrove-loss</u>

<sup>7</sup> "Why the Future of Carbon Should Be Blue," World Economic Forum, July 26, 2021. Retrieved on July 5, 2022, <u>https://www.weforum.org/agenda/2021/07/why-the-future-of-carbon-should-be-blue</u>

<sup>&</sup>lt;sup>8</sup> "The Ultimate Guide to Understanding Carbon Credits," Carboncredits.com. Retrieved on July 5, 2022, <u>https://carboncredits.com/the-ultimate-guide-to-understanding-carbon-credits</u>



Figure 3: Tree Cover Loss in Mangroves by Year, 2000-2012

Source: World Economic Forum, <u>https://www.weforum.org/agenda/2021/07/why-the-future-of-carbon-should-be-blue</u>





Source: NASA (Joshua Stevens, NASA Earth Observatory), https://www.nasa.gov/feature/goddard/2020/nasa-study-maps-the-roots-of-global-mangrove-loss

Using high-resolution data from the joint NASA-U.S. Geological Survey Landsat program, researchers have created the first map of the causes of change in global mangrove habitats between 2000 and 2016 (Figure 4).

The NASA study found that nearly 1,300 square miles of mangrove forests were lost during the study period, or about 2 percent of global mangrove area. Sixty-two percent of the lost area was due to human causes, mainly farming and aquaculture. The rest was due to natural causes, including erosion and extreme weather events. However, losses from natural causes like erosion and extreme weather declined more slowly than human causes such as farming and aquaculture.<sup>6</sup>





Nonetheless, there are reasons for hope – the average rates of global mangrove loss are now slowing, and mangroves are being restored across their endemic lands despite external threats. "But to fully recover mangrove populations and reap their benefits for generations to come," noted a July 26, 2021, article by The Nature Conservancy, "people worldwide will need to come together as allies for these critical systems."<sup>9</sup>

# III. Mangroves Should be Protected

Mangroves are uniquely efficient carbon sinks: locations where carbon is stored out of the atmosphere. They make up only 3 percent of the Earth's forest cover, but if they were all cut down, they could contribute up to 10 percent of global carbon emissions. In 2010, mangroves covered about 53,000 square miles of the Earth's coastlines. The majority of these ecosystems are found in Southeast Asia, but they exist throughout the tropical and subtropical latitudes over the globe.<sup>6</sup>

Source: NASA (Joshua Stevens, NASA Earth Observatory), <u>https://www.nasa.gov/feature/goddard/2020/nasa-study-maps-the-roots-of-global-mangrove-loss</u>

<sup>&</sup>lt;sup>9</sup> "State of the World's Mangroves," The Nature Conservancy, July 26, 2021. Retrieved on July 6, 2022, <u>https://www.nature.org/en-us/what-we-do/our-insights/perspectives/state-of-world-mangroves</u>

At the United Nations Environmental Program (UNEP) climate conference in Lima, Peru, in December 2014, the world was warned that "Global destruction of mangrove forests impacts biodiversity, food security, and the lives and livelihoods of some of the most marginalized communities in the world." The UNEP report found:<sup>10</sup>

• Mangrove forests are being cleared 3-5 times faster than terrestrial forests, costing the world as much as US\$42 billion in economic damages every year.

• Between 2000 and 2010, some 77,107 hectares of Central Africa's mangroves were cleared or degraded, releasing over 100 million metric tons of  $CO_2$  and costing billions in infrastructure maintenance and repairs.

• With around 90 percent of mangroves found in developing countries, UNEP and other organizations asserted the need for a mechanism by which the developed countries of the world should essentially pay developing countries to keep forests intact even as they look for ways to boost their economies and raise their standards of living.

Though coastal and marine ecosystems store more carbon than terrestrial ecosystems, they are just as vulnerable to damage as land-based natural capital assets. Infrastructure development, land-use conversion and poor waste-management are all factors that can damage blue-carbon assets. For example, disturbing a hectare of mangroves releases as much carbon as cutting down between 3 and 5 hectares of tropical forest. Mangroves are thought to be eroding at about 2 percent per annum.<sup>11</sup>



Figure 6: Impacts of Protecting One Hectare of Mangrove

Source: World Economic Forum (Image by Conservation International), https://www.weforum.org/agenda/2021/07/why-the-future-of-carbon-should-be-blue

<sup>&</sup>lt;sup>10</sup> "UN Report Warns of Grave Consequences if Mangroves Not Protected," Mike Gaworecki, Mongabay, March 11, 2015. Retrieved on July 6, 2022, <u>https://news.mongabay.com/2015/03/un-report-warns-of-grave-consequences-if-mangroves-not-protected</u>

<sup>&</sup>lt;sup>11</sup> "Banking on 'Blue Carbon'," Peter Sainsbury, Carbon Risk, July 5, 2022. Retrieved on July 5, 2022, <u>https://carbonrisk.substack.com/p/banking-on-blue-carbon</u>

# IV. Mangrove Forests Around the World

"The State of the World's Mangroves 2021" report provided a comprehensive summary of mangrove's current situation:  $^{\rm 12}$ 

• In 2016, there were some 136,000 km<sup>2</sup> of mangroves worldwide. Southeast Asia houses almost a third of all mangroves.

• There was a net loss of some 4.3 percent of mangroves in the 20 years preceding 2016, but loss is slowing worldwide. In fact, there are a growing number of locations where mangroves are expanding and colonizing new sediments or inland areas.

• Efforts to protect mangroves have risen globally. Currently, around 42 percent of all remaining mangroves exist in designated protected areas.

• At present, the world's mangroves store to over 21 gigatons of CO<sub>2</sub>e.

• Alongside protection, there is an imperative need for restoration. Mangrove restoration science is well advanced. The full return of "highly restorable" areas could restore or stabilize to over 1.3 gigatons of CO<sub>2</sub>e into the atmosphere.

1. <u>Mangroves Found Globally</u>

Most mangroves are found within latitude 25° north and south of equator, covering approximately 170,000 km<sup>2</sup> (17 million hectares) in 112 countries and territories in Asia, Africa, Australia, and the Americas.<sup>13</sup>

The most northerly mangroves can be found in Bermuda, at over 32° north, with the southernmost in Australia at over 38° south. Southeast Asia is the region with the most extensive areas of mangroves, with almost a third of the global total. Indonesia alone is home to almost 20 percent of the world's mangroves. Mangroves are also extensive in other wet tropical areas of South and Central America and in West and Central Africa, forming ample forests particularly around river mouths and deltas such as those of Brazil and Nigeria. In more arid areas, mangroves can still be widespread and both Australia and Mexico are among the world's larger mangrove nations. The two largest areas of continuous mangroves are the Sundarbans – shared by Bangladesh and India – and the Niger Delta in Nigeria, each boasting over 5,000 km<sup>2</sup> of mangroves.<sup>12</sup>

 <sup>&</sup>lt;sup>12</sup> "The State of the World's Mangroves 2021," Global Mangrove Alliance, July 2021. Retrieved on July 9, 2022, <a href="https://www.nature.org/content/dam/tnc/nature/en/documents/state\_of\_word\_mangroves.pdf">https://www.nature.org/content/dam/tnc/nature/en/documents/state\_of\_word\_mangroves.pdf</a>
 <sup>13</sup> "Current Status of South East Asian Mangrove Ecosystems," The Fish Site, March 4, 2009. Retrieved on July 9, 2022,





https://www.nature.org/content/dam/tnc/nature/en/documents/state\_of\_word\_mangroves.pdf

Table 1 shows mangrove extent over time period 1996-2016. Other than the region of East Asia which has not exhibited much change, all other regions experienced loss in mangroves during the data period. The global total decreased from 1996's 141,957 km<sup>2</sup> to 2016's 135,882 km<sup>2</sup>.

REGION	1996	2007	2008	2009	2010	2015	2016
North & Central America & the Caribbean	22,591	21,888	21,986	21,849	20,875	21,205	20,962
South America	19,512	19,105	19,146	19,145	19,127	18,907	18,943
West & Central Africa	20,016	19,913	19,933	19,930	19,916	19,807	19,787
East & Southern Africa	7,577	7,317	7,341	7,332	7,311	7,271	7,276
Middle East	330	321	324	325	324	315	315
South Asia	8,625	8,497	8,493	8,483	8,495	8,404	8,414
Southeast Asia	46,491	44,355	44,378	44,314	44,051	43,587	43,767
East Asia	170	169	167	165	164	170	171
Australia & New Zealand	10,278	10,172	10,186	10,187	10,201	9,980	9,983
Pacific Islands	6,368	6,325	6,326	6,326	6,333	6,278	6,285
GRAND TOTAL	141,957	138,064	138,279	138,054	136,798	135,925	135,882

Table1: Mangrove Extent, 1996-2016 (total area in km<sup>2</sup>)

Source: Global Mangrove Alliance,

https://www.nature.org/content/dam/tnc/nature/en/documents/state\_of\_word\_mangroves.pdf

<u>Figure 8: Protected Area of Mangroves by Region</u> <u>Represented as a Percentage of Total Mangrove Extent, 2016</u>



Source: Global Mangrove Alliance, https://www.nature.org/content/dam/tnc/nature/en/documents/state\_of\_word\_mangroves.pdf

# 2. <u>Mangroves Support a Population of Fishers Around the World</u>

Mangrove-associated fishing, whether it be directly within the mangrove or deriving indirect benefits, can contribute greatly to the livelihoods of coastal communities.

In many countries, over 80 percent of small-scale fishers rely on mangroves, and there are over 4.1 million mangrove fishers globally, each supporting a network or community of dependencies.<sup>12</sup>

As noted in "The State of the World's Mangroves 2021" report, fishing in the mangroves can be very important to smallscale fishers (SSF). Table 2 indicated the most important countries for mangrove fishers, with the modeled estimates of fisher numbers and the proportion of SSF who fish in the mangroves. Table 2: The Most Important Countries for Mangrove Fishers (Modeled estimates)

COUNTRY	Mangrove fisher estimate	Percentage SSF mangrove fishers
Indonesia	893,000	39%
India	570,000	38%
Bangladesh	286,000	82%
Myanmar	286,000	69%
Brazil	278,000	53%
Vietnam	240,000	44%
Mexico	208,000	73%
Nigeria	150,000	89%
Thailand	127,000	55%
Philippines	118,000	41%

Source: Global Mangrove Alliance,

https://www.nature.org/content/dam/tnc/nature/en/ /documents/state\_of\_word\_mangroves.pdf

# V. Top Ten Mangrove Forests in the World

The Top 10 mangrove forests in the world totaled more than 29,000 km<sup>2</sup>, translating to over 21 percent of total area in the world covered by mangroves.

	Name of Mangrove	Size	Location		
	Forest				
1	Sundarbans – the largest	$\sim 10,000 \text{ km}^2$ :	The Delta of the Ganges and		
	mangrove ecosystem in	Bangladesh: 6,017 km <sup>2</sup>	Meghna Rivers		
	the world	India: $4,260 \text{ km}^2$			
2	Pichavaram	11 km <sup>2</sup> (1,100 hectares)	Tamil Nadu, India		
3	Florida	1,900 km <sup>2</sup>	Florida, USA		
4	Bahia	2,100 km <sup>2</sup>	Northeastern Brazil		
5	Godavari-Krishna	194.81 km <sup>2</sup>	Krishna-Guntur District, Andhra		
			Pradesh		
6	Gulf of Panama	2,330 km <sup>2</sup>	Bay of San Miguel in the Pacific		
			coast of the Panama-Colombia		
			border		
7	Indus River Delta-Arabian	2,428 km <sup>2</sup>	The shore of Indus River and the		
	Sea		Arabian Sea		
8	Belizean Coast	2,850 km <sup>2</sup>	Amatique Bay in Guatemala along		
			with the coast of Belize		
9	Greater Antilles	6,134 km <sup>2</sup> :	Between Cuba proper and Isla de		
		Cuba: 5,569 km <sup>2</sup>	la Juventud		
		Haiti: 134 km <sup>2</sup>			
		Dominican Republic: 325			
		km <sup>2</sup>			
		Jamaica: 106 km <sup>2</sup>			
10	Manabi	1,000 km <sup>2</sup>	Ecuador (at the side of the Pacific		
			coast)		

Table 3:	Тор	10 N	langr	ove For	ests in	the	World

Table compiled by Royal Roots Global Inc. Sources:

Travel Mate, <u>https://www.travelmate.com.bd/top-10-largest-mangrove-forest-in-the-world</u> Wikipedia, <u>https://en.wikipedia.org/wiki/Sundarbans</u>

Florida Department of Environmental Protection, <u>https://floridadep.gov/rcp/rcp/content/floridas-mangroves</u> Forest Department of the Government of Sindh, <u>https://sindhforests.gov.pk/page-mangroves</u> Wikipedia, <u>https://en.wikipedia.org/wiki/Greater\_Antilles\_mangroves</u>

# VI. Countries with the Most Concentration of Mangroves

Close to half of the world's mangrove coverage, according to a 2009 article by The Fish Site, occurred in five countries: Indonesia, Brazil, Australia, Nigeria, and Mexico.<sup>13</sup>

# 1. Indonesia

According to a July 26, 2021, World Bank news report<sup>14</sup>, Indonesia holds 3.5 million hectares (35,000 km<sup>2</sup>) of mangroves, about 23 percent of the world's total, and is the most diverse with 92 true mangrove species.

The report further noted that Indonesia experiences significant mangrove loss annually. The majority of loss is driven by mangroves being converted into aquaculture ponds, mostly for shrimp, in Kalimantan and Sulawesi. The remaining loss is due to conversion to palm oil plantation and coastal development for urban expansion. The U.N. Food and Agriculture Agency (UN-FAO) estimated in 2007 that 40 percent of Indonesia's mangroves had been cut down for aquaculture projects and coastal development in the previous three decades<sup>15</sup>.

In 2020, the Indonesia government set an ambitious target of planting mangroves on 600,000 hectares (6,000 km<sup>2</sup>) of degrading coastline by 2024. Key ministries are involved in restoration efforts that include community outreach and education.<sup>15</sup>

#### 2. <u>Brazil</u>

Mangroves cover 13,989 km<sup>2</sup> along Brazil's coast<sup>16</sup>. Mangroves are found along practically the entire Brazilian coastline, from Amapá state in the north to Santa Catarina in the south. By state, Maranhão has the largest area of mangroves, at nearly 298,000 hectares (2,980 km<sup>2</sup>), followed by Pará's 186,000 hectares (1,860 km<sup>2</sup>), and Amapá's 141,000 hectares (1,410 km<sup>2</sup>). Maranhão and Pará combined are home to 60 percent of Brazil's mangrove area<sup>17</sup>. Along the Brazilian coast occur three types of mangrove species: the red, the white, and the black mangrove<sup>18</sup>.

In 2020, the Brazilian government approved legislation that would have eliminated mangrove protection for the benefit of real estate development. Fortunately, in December 2021, the Brazilian Supreme Court found the controversial policy unconstitutional, and Brazil must continue to protect its mangroves.<sup>19</sup>

<sup>15</sup> "Restoring Mexico's Mangroves can Shield Shores, Store Carbon," Maria Verza, Christina Larson and Victoria Milko, Associated Press, ABC News, November 5, 2021. Retrieved on July 10, 2022,

https://abcnews.go.com/Technology/wireStory/restoring-mexicos-mangroves-shield-shores-store-carbon-80986815 <sup>16</sup> "Brazil's Mangroves on the Front Line of Climate Change," Nacho Doce, Reuters, March 28, 2019, Retrieved on July 9, 2022, <u>https://www.reuters.com/article/us-brazil-environment-mangrove-forest-idUSKCN1SY13S</u>

<sup>17</sup> "A More Potent CO2 Sink than the Amazon, Brazil's Mangroves Remain Overlooked," Suzana Camargo, Mongabay, March 3, 2022. Retrieved on July 10, 2022, <u>https://news.mongabay.com/2022/03/a-more-potent-co2-sink-than-the-amazon-brazils-mangroves-remain-overlooked</u>

<sup>18</sup> "Brazil Eco," Travel Mangrove. Retrieved on July 10, 2022,

http://www.braziltourstravel.com/ecosystem/mangrove.htm

<sup>19</sup> "Brazil's Mangroves: Natural Carbon Storage," Denilson da S. Bezerra et al, Science, March 17, 2022. Retrieved on July 10, 2022, <u>https://www.science.org/doi/10.1126/science.abo4578</u>

<sup>&</sup>lt;sup>14</sup> "Mangrove Conservation and Restoration: Protecting Indonesia's 'Climate Guardians'," The World Bank, July 26, 2021. Retrieved on July 9, 2022, <u>https://www.worldbank.org/en/news/feature/2021/07/26/mangrove-conservation-and-restoration-protecting-indonesia-climate-guardians</u>

Around 70 percent of Brazilian mangroves are today inside preserved areas, but the effectiveness of these advances continues to be negatively impaired by bureaucracy, lack of conservation policies and economic interests. Restoration efforts have somewhat minimized losses, but has recuperated only a 5 percent of the total degraded area.<sup>20</sup>

# 3. <u>Australia</u>

Australia has approximately 11,500 km<sup>2</sup> of mangroves, primarily on the northern and eastern coasts of the continent. Nearly half of Australia's mangrove forests are found in Queensland (44% of Australia's total), followed by the Northern Territory (37%) and Western Australia (17%). Australian mangrove forests comprise 45 plant species from 18 families.<sup>21</sup>

In the Australian summer of 2015-16, over 7,000 hectares (70 km<sup>2</sup>) of mangroves along 1,000 km's of coastline in the Gulf of Carpentaria died as a result of low rainfalls, extreme heat, and low sea-levels. This was one of the worst mangrove die-back events ever recorded.<sup>22</sup>

Australia's mangroves are largely low-impacted and protected by their isolation. They are rarely exploited directly and most occupy the least populated northern coast. Although relatively lightly populated, compared with other large countries with mangroves, Australia has over 85 percent of its population living within 50 km of the coast. The trend to move to the coast continues, with all States and Territories reporting their highest population growth rates within 3 km of the coast, increasing threats to diminishing natural habitats for mangroves.<sup>23</sup>

#### 4. <u>Nigeria</u>

Nigeria has the largest reserve of mangroves in Africa, with some 8,000 km<sup>2</sup> (800,000 hectares) of mangroves<sup>24</sup> and composed of six mangrove species<sup>25</sup>. Mangrove swamps in Nigeria stretch along the entire coast. They are found in nine of the 36 states, namely Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers States, collectively referred to as the Niger Delta. And, approximately 80 percent of the

<sup>&</sup>lt;sup>20</sup> "Degradation and Conservation of Brazilian Mangroves, Status and Perspectives," Alexander Cesar Ferreira, Luiz Drude Lacerda, Science Direct, Volume 125, Pages 38-46, June 2016. Retrieved on July 10, 2022, https://www.sciencedirect.com/science/article/abs/pii/S0964569116300369

<sup>&</sup>lt;sup>21</sup> "Australian Mangroves," Wikipedia. Retrieved on July 9, 2022, <u>https://en.wikipedia.org/wiki/Australian\_mangroves</u> <sup>22</sup> "While Australia Burns under a Changing Climate, our Mangroves Die-Off," Yota Harada, January 10, 2020. Retrieved on July 10, 2022, <u>https://catchmenttocoast.org/2020/01/10/while-australia-burns-under-a-changing-climate-our-</u> <u>mangroves-die-off</u>

 <sup>&</sup>lt;sup>23</sup> "Australia," Mangrove Watch, 2018. Retrieved on July 10, 2022, <u>http://mangrovewatch.org.au/regions/australia</u>
 <sup>24</sup> "Current Status and Conservation of Mangroves in Africa: An Overview," Gordon Ajonina, Abdoulaye Diame and J.G. Kairo, Research Gate, April 2018. Retrieved on July 10, 2022,

https://www.researchgate.net/publication/324784251 Current status and conservation of mangroves in Africa An overview

<sup>&</sup>lt;sup>25</sup> "Niger Delta Mangroves," Wikipedia. Retrieved on July 10, 2022, <u>https://en.wikipedia.org/wiki/Niger\_Delta\_mangroves</u>

Delta's mangroves are distributed in only three states: Bayelsa, Delta, and River states. The largest extent of mangroves is found in the Niger Delta between the Benin River region in the west and Calabar, Rio del Rey estuary in the east<sup>26</sup>.

As noted in the book "Habitats of the World," there is a gradual but steady loss of mangrove forests in the Niger Delta due to uncontrolled deforestation for the purpose of sand dredging and canalization. Mangrove forest is also cut to recover stems, which are used in the production of firewood and wood for the construction of houses.<sup>27</sup>

In 2020, the Nigeria government, through the Department of Forestry, undertook a Mangrove Restoration Project, known as "Mangrove for Life Project", aiming to restore degraded and manage existing mangrove forests in Nigeria.<sup>28</sup>

## 5. <u>Mexico</u>

There are some 7,000 km<sup>2</sup> (700,000 hectares) of mangroves in Mexico<sup>29</sup>, located both in the Atlantic and Pacific coasts. On the Atlantic coast, mangroves are found from the southern part of Quintana Roo state on the Yucatan peninsula up to the Madre Lagoon in Tamaulipas state in the north. Along the Pacific coast, mangroves are found up to Baja California state, but stop before the border. The largest and best developed mangrove areas are associated with lagoons in the south and east of the country<sup>30</sup>. Four species of tropical mangroves can be found around the Gulf of Mexico<sup>31</sup>.

Mangroves areas have been cleared over the years for agriculture, mariculture, and urban development. They are also being increasingly used for firewood in coastal areas<sup>30</sup>.

Mexico began to protect some of its mangroves only after the excessive tourism development of the 1980's. And although Mexico took steps to establish a climate action plan in 1998 and was one of the first developing countries to make voluntary commitments under the Paris Climate Accord, its commitment to the environment began to backslide in 2015 as the country cut resources for environmental conservation

<sup>&</sup>lt;sup>26</sup> "Mangrove Forests in Nigeria: Why Their Restoration, Rehabilitation and Conservation Matters," Paulinus Chukwumaucheya Aju, Research Gate, January 2021. Retrieved on July 10, 2022,

https://www.researchgate.net/publication/353015011 mangrove forests in nigeria why their restoration rehabilitation nation natio

<sup>&</sup>lt;sup>27</sup> "Mangrove Habitat Loss and the Need for the Establishment of Conservation and Protected Areas in the Niger Delta, Nigeria," Aroloye O. Numbere, IntechOpen, April 21, 2019. Retrieved on July 10, 2022, https://www.intechopen.com/chapters/70413

<sup>&</sup>lt;sup>28</sup> "FG to launch Mangrove Restoration Project in Niger Delta," Joseph Erunke, Vanguard, July 26, 2020. Retrieved on July 10, 2022, <u>https://www.vanguardngr.com/2020/07/fg-to-launch-mangrove-restoration-project-in-niger-delta</u>

<sup>&</sup>lt;sup>29</sup> "Loss of Mexico's Valuable Mangrove Forests," Madelin Andersen, Center for Marine Biodiversity and Conservation, May 15, 2018. Retrieved on July 10, 2022, <u>https://cmbc.ucsd.edu/2018/05/15/loss-of-mexicos-valuable-mangrove-forests</u>

<sup>&</sup>lt;sup>30</sup> "Mangrove Management," Food and Agriculture Organization of the United Nations. Retrieved on July 10, 2022, <u>https://www.fao.org/forestry/mangrove/vegetation/en/mex</u>

<sup>&</sup>lt;sup>31</sup> "Mangrove Swamps," United States Environmental Protection Agency. Retrieved on July 10, 2022, <u>https://www.epa.gov/wetlands/mangrove-swamps</u>

by 60 percent, in addition to the government's increasing support of fossil fuel energy and ongoing infrastructure and tourist projects.<sup>15</sup>

Restoration of mangroves on the Yucatan Peninsula is underway, and successes exist, even if they are slow in coming. However, the mangroves there may face illegal logging risks when the planted seedlings become full-grown trees. Cutting mangroves has been a crime in the country since 2005, but authorities shut down and fine projects, only to have them later reopen.<sup>15</sup>

# **VII.** Conclusion

As one of the coastal ecosystems that widely exists all over the world, mangroves exhibit a unique ability to sequester carbon, mitigate climate risk, improve livelihoods, and safeguard biodiversity.

Some 90 percent of all mangroves are found in developing countries, which are still in the development phases to boost their economies and raise their citizens' standards of living. They should not, however, compromise their mangroves resources for short-term development achievements. This coastal ecosystem not only can help the world fight climate issues, but can also improve the livelihoods of the people and add to food security.

Climate change is a global risk and should be dealt with on a global basis. Since blue-carbon mangrove forests can offer potential solution to the global climate issue, their preservation demands the attention and actions from stakeholders around the world.

Cooperation is the key to succeed.