

Drivers of Mangrove Change

What is causing mangrove change in Southeast Asia and where are these changes occurring?

1

INTRODUCTION

Mangrove trees are vital in mitigating climate change because they store up to four times as much carbon compared to land-based forests¹, act as buffers against storm surges, and provide habitat to both marine life *and* terrestrial life. However, mangrove forests are being threatened. Global mangrove deforestation continues but at a much reduced rate of between 0.16% and 0.39% per year. Southeast Asia is a region of concern with mangrove deforestation rates between 3.58% and 8.08%, a region containing half of the entire global mangrove forest inventory². Mangrove deforestation in this region is driven primarily by large-scale agricultural and aquacultural commodity production, coastal development and sea level rise.³

Due to their importance, mangrove forests are also being targeted for reforestation efforts, especially in areas that are vulnerable to climate change and have a history of deforestation like Southeast Asia. Therefore, this research project is focused on identifying drivers of mangrove change in Southeast Asia to better understand the trajectory of mangrove change and if the changes are aligning with current initiatives to combat climate change, primarily the Paris Agreement and the United Nations Sustainable Development Goal (SDGs) #15, Life on Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.⁴

2

METHODS

- This project is a meta-analysis (statistical analysis that combines the results of multiple scientific studies) of current mangrove databases of Southeast Asia. Data was acquired mainly through peer-reviewed literature, NGO reports, and other forms of grey literature respectively.
- Both satellite-based and land-based data were used.
- Data pertaining to where, when, and the drivers of mangrove change were compiled into an excel database that would then be integrated into an ArcGIS geodatabase map. For the purposes of making the data as recent/relevant as possible, data before 1960 were ignored.
- The ArcGIS map is categorized by six main drivers of mangrove change: Government (Govt), Non-government organization (NGO), Agriculture/Aquaculture, Extreme Weather, Urbanization, and Other. Other includes anthropogenic causes that are too infrequent to make their own category, such as; boat traffic, trash, and erosion (Figure 1). Agriculture/aquaculture drivers is vastly comprised of shrimp farming. Conversion of mangrove forests to aquaculture ponds for shrimp production is especially evident in Southeast Asia. For example, in Thailand, the total value of export earnings for shrimp in the late 1990s was around US\$1-2 billion annually.⁵
- Limitations include time and man-power constraints limiting the amount of data compiled and the lack of quantitative data pertaining to illegal mangrove changes (ex. illegal mangrove logging).

Figure 1. Severe erosion undercutting mangroves at the Main Bridge, Sungei Buloh, March 2010. (Wild Shores of Singapore, "Saving Singapore's last best mangroves at Pulau Tekong")



3

RESULTS

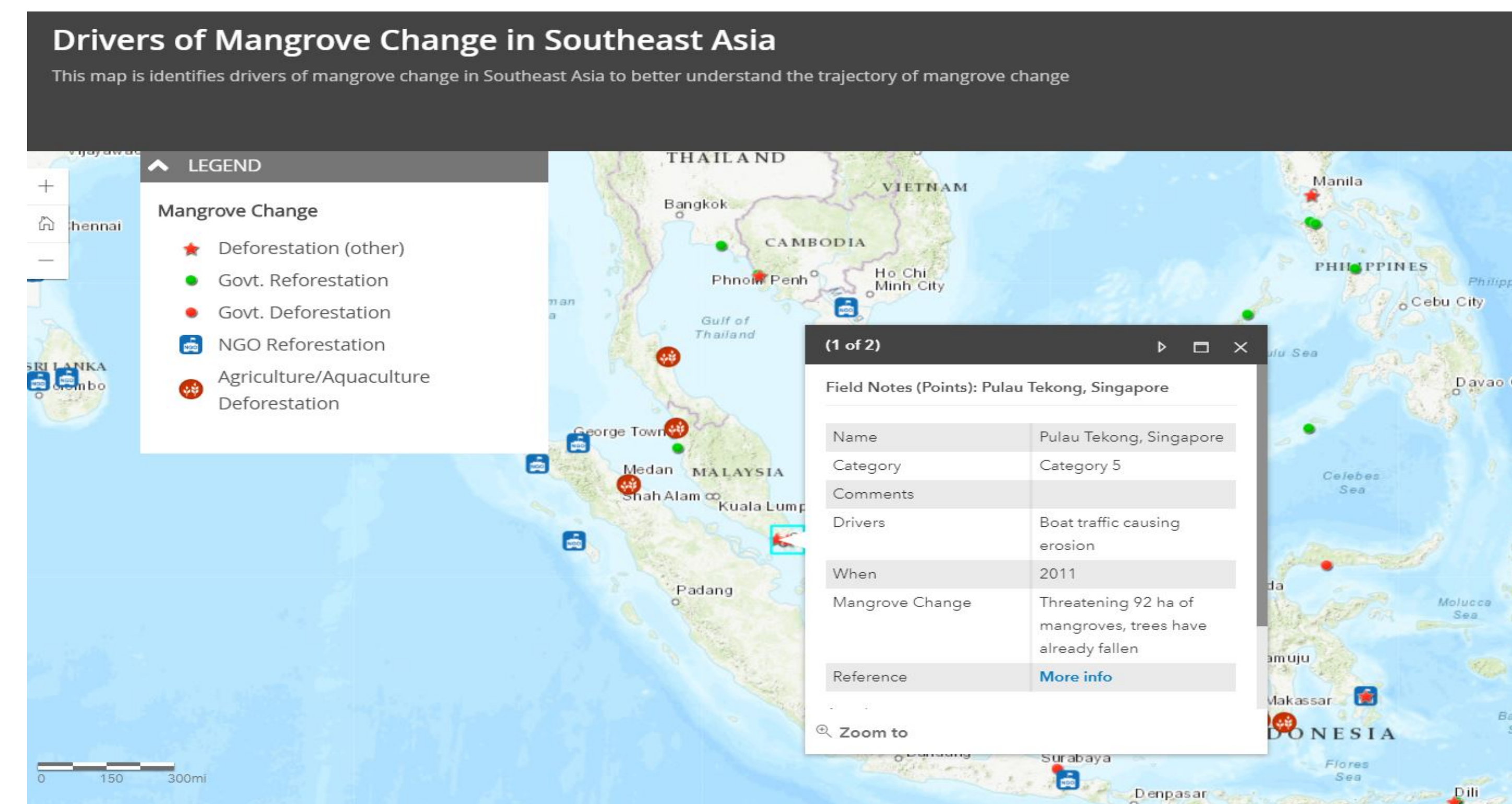


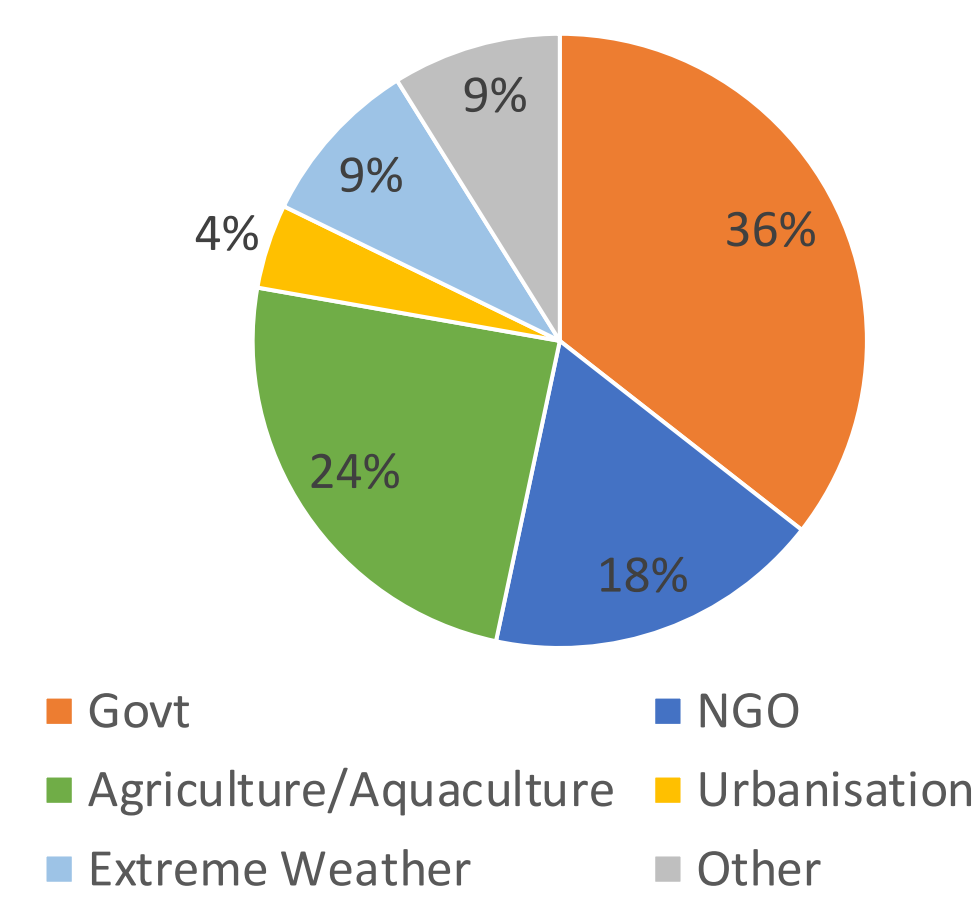
Figure 2. ArcGIS online geodatabase map: <https://arcg.is/1KOL800>

Figure 2 is a geodatabase map consisting of forty-five plotted points of mangrove change across Southeast Asia, including parts of India and Sri Lanka. By clicking on one of the points, a text box appears that provides information about that point, such as the extent of the change and references. Some points include images of the area itself to provide more visual context. Limitations of this map include how the points do not accurately represent the area of change.

Based on the geodatabase, three pie charts below represent how the different drivers correlate with specific mangrove change:

Figure 3

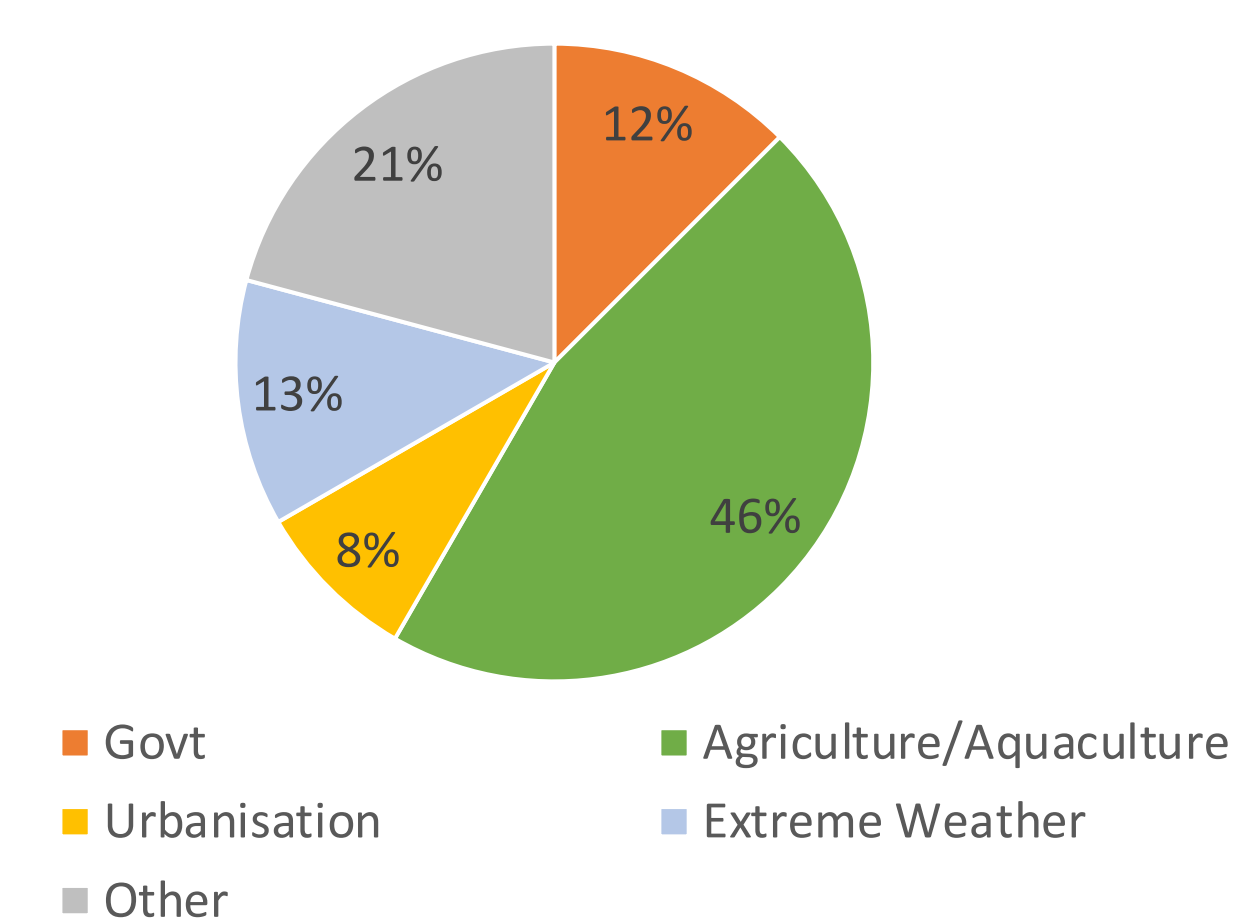
Total Drivers of Mangrove Change



- Figure 3 shows that out of the 45 total instances of mangrove change, the government had the most involvement with these changes, second is NGOs, following in third is agriculture.
- The least common driver is urbanisation.
- Some instances of mangrove change have multiple drivers. Ex. government regulation incentivizing agriculture production.

Figure 4

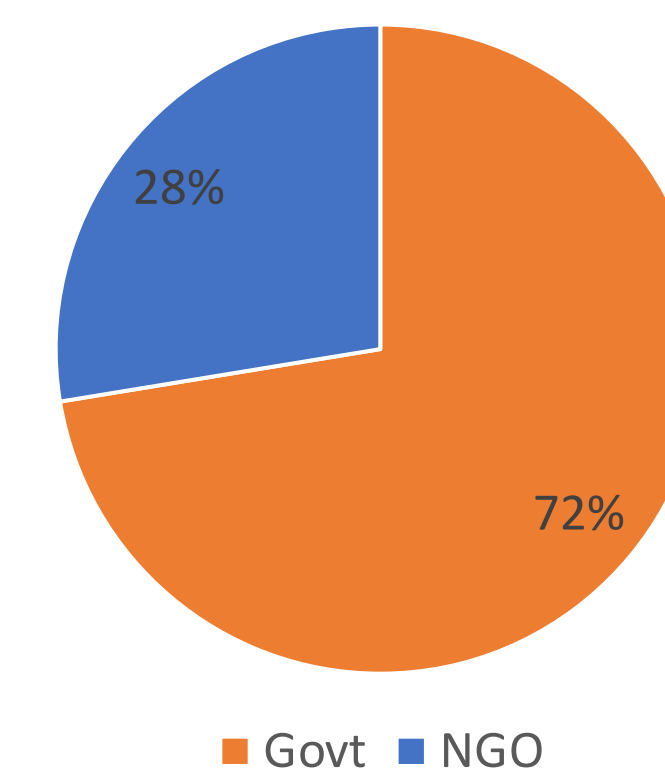
Drivers of Mangrove Deforestation



- Figure 4 shows the instances of mangrove deforestation were mostly caused by agriculture/aquaculture following other anthropogenic causes.
- Five of the six drivers are causing mangrove deforestation.
- The least common driver is government and urbanisation.
- 24 of the 45 instances of mangrove change are associated with deforestation.

Figure 5

Drivers of Mangrove Reforestation



- Figure 5 shows the instances of mangrove reforestation were mostly caused by government action following NGOs.
- Two of the six drivers are causing mangrove reforestation.
- 29 of the 45 instances of mangrove change are associated with reforestation.

4

DISCUSSION

The results show government action being the main driver in mangrove change. There is indication that Southeast Asian government actions are aligning with climate change initiatives because they have the highest impact in reforestation and one of the lowest impact in deforestation. Figure 6 shows the alignments between the National Determined Contributions (NDC) from the Paris agreement and the targets of SDG goal 15, Life on Land. South east Asia countries have at least two targets linked, with Vietnam having the highest links (six links) among them. Comparing it with Figure 2-5, there is a positive correlation between the amount of linkages and government drivers of mangrove reforestation.

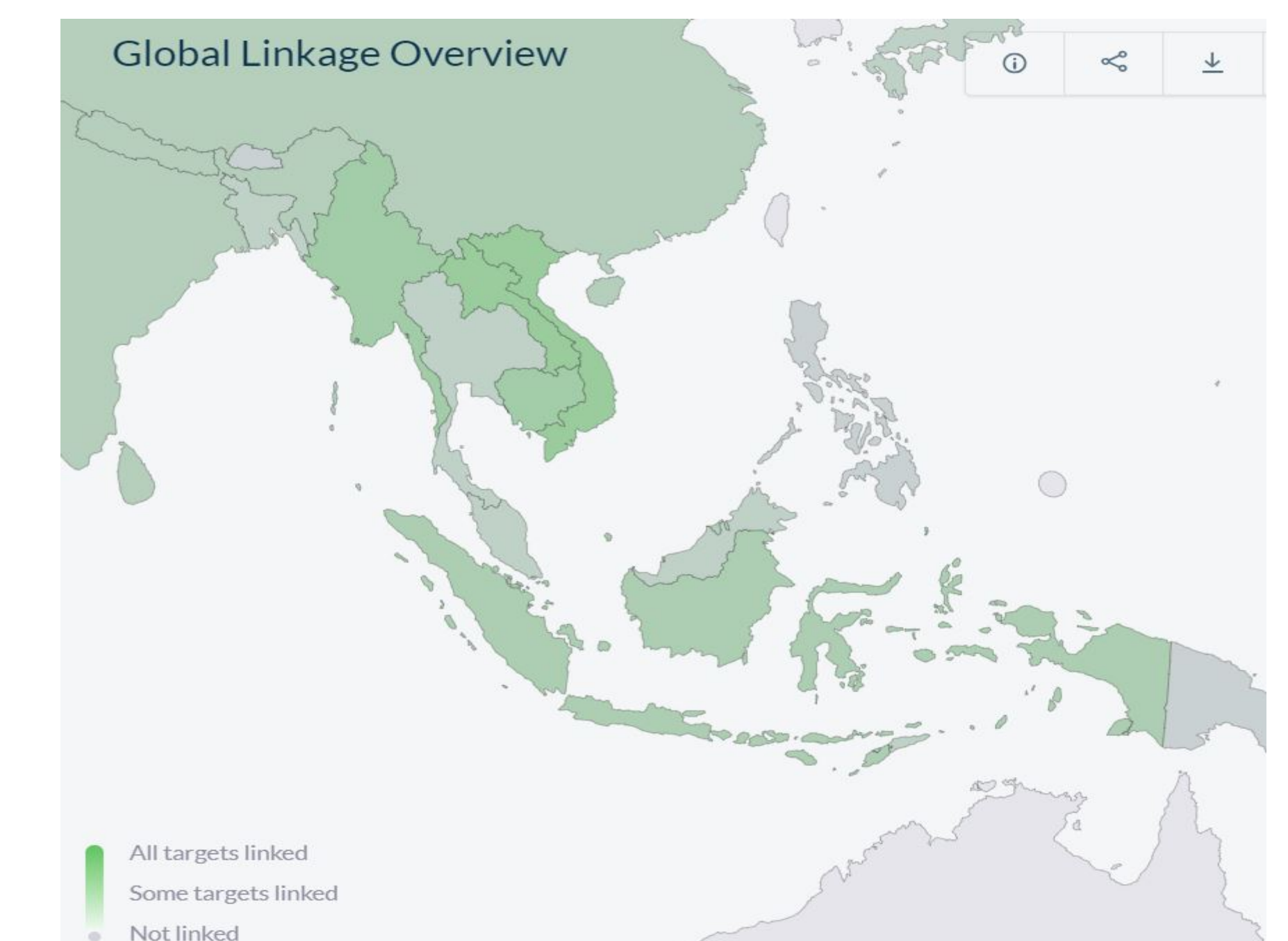


Figure 6. ClimateWatch, NDC-SDG Linkages⁶

One of the peer-reviewed articles used in this project studied the effectiveness of eight mangrove rehabilitation projects in the Philippines and found that despite heavy funding to rehabilitate thousands of hectares of mangroves over the last two decades, the **long-term survival rates of mangroves are generally low at 10-20%**. Issues that were identified in this study that impede success of mangrove rehabilitation and conservation efforts include lack of awareness, complexity of interactions between natural systems, social systems, and human values, weak and inadequate manpower, and lack of political will to enforce the laws (Primavera and Esteban 2008)⁵. Likewise, other papers and reports have similar findings, ultimately there is a general weak infrastructure of mangroves rehabilitation in Southeast Asia that impedes reforestation efforts. This raises questions such as what is the most efficient way to restore and rehabilitate mangroves? One potential solution is to invest more in environmental education programs for communities to sustain and plant mangroves themselves.



Maldives, one of the most vulnerable countries to climate change due to high risk of intensifying weather events and sea level rising, converted a mangrove habitat into an airport. (SixDegrees. "Mangroves Destruction in Maldives- Islands' Biggest Ecocide.")

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