# Project Idea Note (PIN)

Project Title:
**Restoration of abandoned or under-utilised shrimp farms to mangroves on village owned land in SE Sulawesi, Indonesia**






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## Summary Information

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|---|---|
| Project Title | Restoration of abandoned or under-utilised shrimp farms to mangroves on village owned land in SE Sulawesi, Indonesia |
| Project Location – Country/Region/District | This project is located in Southeast Sulawesi with mangrove reforestation sites spread across communal land belonging to 35 villages in three districts / regencies (Bombana, Konawe Selatan and Muna). |
| Project Coordinator & Contact Details | Dr Tim Coles, rePLANET, Wallacea House, Old Bolingbroke, Spilsby, Lincolnshire, PE23 4EX |
| Summary of Proposed Activities<br>(Max 30 words) | To provide financial incentives to small scale fish farms that are not making money, to convert the farms back to mangroves |
| Summary of Proposed Target Groups<br>(Max 30 words) | Fish and shrimp pond farmers in 35 villages in SE Sulawesi, Indonesia |

## Part A: Project Aims & Objectives

Blue carbon ecosystems (BCEs) such as mangroves provide enormously important ecosystems services to local communities (Quevedo et al., 2021), including habitats and nurseries for commercially important fish and invertebrate species, fuel wood supplies, protection from erosion and storms, and recreation and education**.** Since mangroves store large amounts of carbon derived from the atmosphere for long periods of time, losses of such ecosystems result in huge carbon emissions (Adame et al., 2021), especially within Southeast Asia, and Indonesia in particular. One of the major causes of mangrove loss in Indonesia is conversion for use as shrimp or fish farms. This happens in areas where the mangroves have been allocated to village communities on maps produced by BPKH (department in the Ministry of Environment that produces the usage zonation maps for each province). Mangroves are allocated to individual families who then clear the mangroves and construct shrimp ponds (each generally around 1 hectare in size, though can be larger or smaller). Once constructed they then use loans to purchase seed stock (juvenile shrimp) that are released into the pond. In theory the shrimp can be harvested in 3 – 4 months, but in many cases the crops fail because of mass mortalities of shrimp (de-oxygenation, temperatures too high because of lack of shading, etc). For many of the pond operators there are multiple failures for every successful crop. Often these enterprises increase the indebtedness of already poor families, so it is common to find large areas of the shrimp ponds not being utilised.

This project offers shrimp farmers who are not using or under using their ponds an opportunity to cash in their investment by having their land reforested with mangroves. Across the study area around 39% of the ponds are disused and, in some villages, it can be as high as 75%. All owners of ponds in village allocated lands will be offered three options, although those operating successful ponds are unlikely to participate:

1. To sell their pond to a community trust which will then reforest the area with local mangrove species and use at least 60% of the income raised from sales of carbon credits to make bi-annual payments or development

of alternative income streams (e.g. mud crab fattening, bees) to those communities.

2. To lease the pond area for 25 years with an upfront payment approximately 60% of the buyout costs, but with the option of converting to a full buy out if they change their mind over time. The leased areas would be converted to mangrove forest and the carbon credit income would be used to make community payments or for the development of alternative income streams.
3. To convert their ponds to eco-empangs (see description below) where half of the area is restored to mangroves but the remaining channels which are now shaded are still used for shrimp production.

Note there are many other areas of mangroves designated as government protected forest but where local communities illegally clear areas in the hope that the land will eventually be re-designated as village land. None of these areas are included in this application and these cleared areas are the responsibility of the Indonesian govt who have plans using BPDAS to replant Mangroves. Note BPDAS is not able to reforest the privately owned, village-controlled areas.

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# Part B: Proposed Project Area

## B1) Description of Project Location

### Project Location

This project will be implemented in deforested mangrove locations across 35 villages within Muna Island and Bombana and Konawe Selatan regencies in Southeast Sulawesi (Table 1 and Figures 1, 2 and 3), that have over the past two decades been converted into fishponds (*empangs*) or logged for timber and fuel (Muna island only) and which are headed for use as empangs. As table 1 shows there is a total of 1729 hectares of abandoned fishponds across these three areas that total nearly 4500 hectares.

### Physical description of the land, habitat types and land use

Muna Island and the regencies of Bombana and Konawe Selatan in Southeast Sulawesi province (Figures 1, 2 and 3) are characterized by a tropical rainforest climate, with moderate rainfall from August to November and heavy rainfall from December to July, and encompass a variety of habitats, including peat swamp, lowland, montane and karst forest, grasslands, diverse agricultural lands, and mangrove forests (Whitten et al., 1987). The characteristics of the coastal areas differ from those further inland; however, they are social-ecologically interrelated (Rahman et al., 2020). One of the most important ecological systems found throughout the coastline of Bombana, Konawe Selatan and Muna is mangrove forests (Figure 4), largely dominated by mangrove species such as *Rhizophora apiculata*, *Rhizophora mucronata*, *Ceriops tagal*, *Bruguiera gymnorrhiza*, *Lumnitzera racemosa*, *Xylocarpus granatum* and *Sonneratia alba* (Analuddin et al., 2013; Analuddin et al., 2020). Mangrove forests throughout these three areas are often utilized by humans (Bunting et al., 2018; Eddy et al., 2021), with excessive use leading to ecological pressures and damage due to land conversion into ponds (Figure 6), settlements, firewood (Figure 8) and industrial plantations. Consequently, mangrove deforestation leads to carbon loss due to decreased absorption rate and increased concentrations of greenhouse gases resulting from the oxidation of exposed areas of sediment (Castillo et al., 2017; Rahman et al., 2020).

**Table 1**. Summary information on total amount of deforested mangrove areas converted into fishponds (empangs) in the past two decades with potential for reforestation in the 35 villages included in this project. The values here displayed represent only areas outside both the Indonesia's NDC or already targeted locations for mangrove rehabilitation by government agencies under the Ministry of Environment and Forestry like the Mangrove Restoration Agency (BRGM) and the Watershed Management Centre (BPDAS).

| | | | ***Empang* area (hectares)** | | |
|---|---|---|---|---|---|
| **Regency** | **District** | **Village** | **Active** | **Abandoned** | **Total area** |
| Konawe | Moramo | Ranooha Raya | 119.0 | 155.3 | 274.3 |
| | Tinanggea | Roraya | 148.8 | 81.2 | 230. |
| | | Pongosi | 125.4 | 28.0 | 153.4 |
| | | Asingi | 56.9 | 69.8 | 126.7 |
| | | Lasuai & Lapulu | 198.3 | 69.4 | 267.7 |
| | Kolono | Awunio | 69.6 | 149.1 | 218.7 |
| | | Silea | 97.7 | 19.9 | 117.6 |
| | | Langgowala | 69.9 | 29.9 | 99.8 |
| | | Meletumbo | 10.3 | 18.0 | 28.3 |
| | Lainea | Pamandati | 32.2 | 35.8 | 68.0 |
| | | Lalonggombu | 9.1 | 36.3 | 45.4 |
| | Palangga Selatan | Lakara | 32.9 | 35.8 | 68.7 |
| Bombana | Lantari Jaya | Lantari | 273.8 | 90.0 | 363.8 |
| | | Asare Apua | 313.1 | 139.1 | 452.2 |
| | Raowatu Utara | Tunas Baru | 321.4 | 0.0 | 321.4 |
| | | Hukaeya | 84.5 | 111.4 | 195.9 |
| | Rumbia | Daole | 110.5 | 34.9 | 145.4 |
| | | Kasipute | 9.1 | 20.3 | 29.4 |
| | Rumbia Tengah | Tapuahi & Lampata | 7.0 | 20.1 | 27.1 |
| | | Mawar | 0.0 | 2.5 | 2.5 |
| | Mata Oleo | Kec Laora | 4.1 | 20.3 | 24.3 |
| | Poleang Tengah | Mulaeno | 68.7 | 29.5 | 98.2 |
| | | Paria | 60.2 | 20.1 | 80.2 |
| | Poleang | Boeara & Boepinang | 49.9 | 49.9 | 99.8 |
| Muna | Lasalepa | Bonea | 0.0 | 46.8 | 46.8 |
| | Katobu | Pelabuhan Muna | 0.0 | 99.1 | 99.1 |
| | Parigi | Labulubulu | 51.8 | 0.0 | 51.8 |
| | Kabangka | Oensuli | 119.5 | 57.8 | 177.3 |
| | Kabowo | Kawite-wite | 142.9 | 130.9 | 273.8 |
| Muna Barat | Napano Kusambi | Lantawe | 30.2 | 30.2 | 60.3 |
| | Tiworo Utara | Tondasi | 3.1 | 62.3 | 65.4 |
| Buton Tengah | Mawasangka | Tanailandu | 138.2 | 35.3 | 173.5 |
| **Total** | | | **2758,1** | **1729** | **4486,8** |

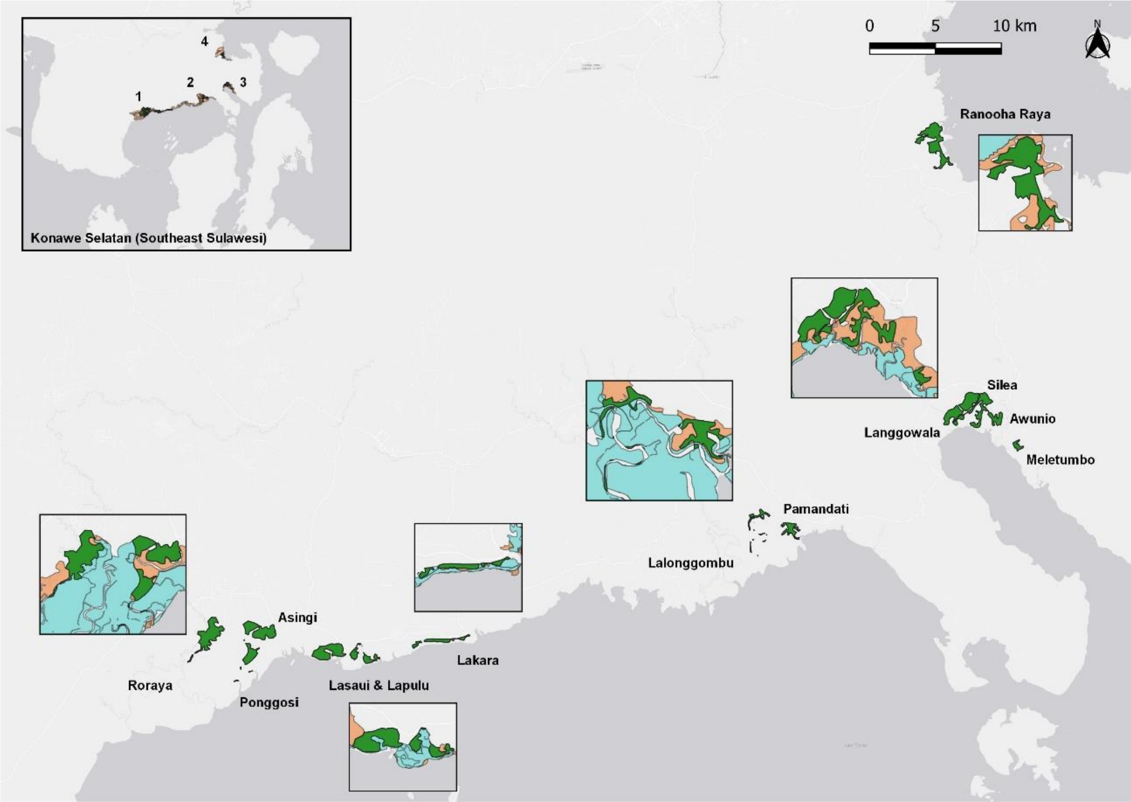


**Figure 1**. Project sites in the Konawe Selatan regency in Southeast Sulawesi. Green indicates our target locations for mangrove reforestation, orange represents areas currently included in Indonesia's NDC (Nationally Determined Contributions), light blue represents areas already targeted for rehabilitation by the Indonesian government (govRehab) and labels indicate the name of the villages included in this project. There is no overlap between our proposed areas and Indonesia's NDC and govRehab.

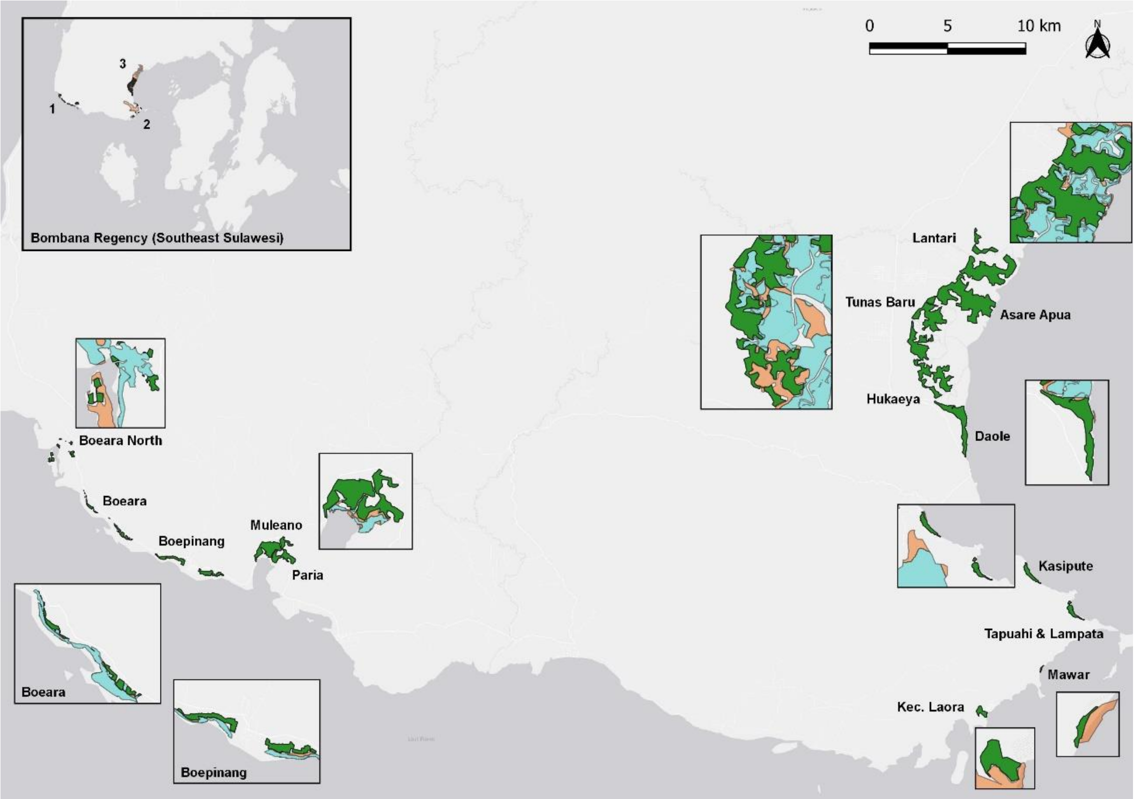


**Figure 2**. Project sites in the Bombana regency in Southeast Sulawesi. Green indicates our target locations for mangrove reforestation, orange represents nearest areas currently included in Indonesia's NDC (Nationally Determined Contributions), light blue represents areas already targeted for rehabilitation by the Indonesian government (govRehab) and labels indicate the name of the villages included in this project. There is no overlap between our proposed areas and Indonesia's NDC and govRehab.

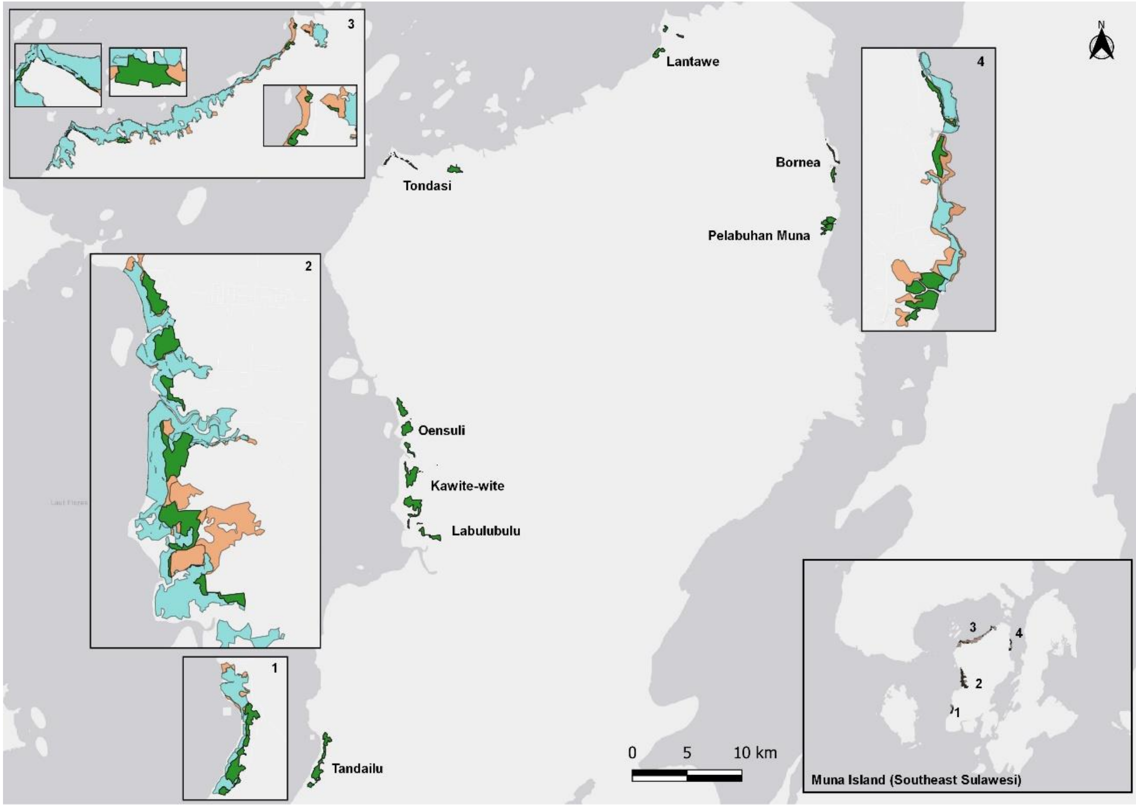


**Figure 3**. Project sites on Muna island in Southeast Sulawesi. Green indicates our target locations for mangrove reforestation, orange represents nearest areas currently included in Indonesia's NDC (Nationally Determined Contributions), light blue represents areas already targeted for rehabilitation by the Indonesian government (govRehab) and labels indicate the name of the villages included in this project. There is no overlap between our proposed areas and Indonesia's NDC and govRehab.

**Figure 4**. Undisturbed mangrove forested area in the villages of Pamandati (Lainea – Konawe Selatan) and Boeara (Poleang – Bombana) in Southeast Sulawesi.

### Identification of legally designated/protected conservation areas adjacent to the project areas

All sites proposed for mangrove reforestation in this project are located outside natural protected areas, with the closest proximity being two locations in the western portion of the Bombana regency (villages of Asare Apua and Lantari; Figures 2 and 5) that are adjacent to the most western portion of the Rawa Aopa Watumohai National Park (RAWNP). Furthermore, although many of our proposed sites are adjacent to areas included in Indonesia's Nationally Determined Contribution (NDC) or already targeted areas for mangrove rehabilitation (govRehab) by government authorities like the Mangrove Restoration Agency (*Badan Restorasi Gambut dan Mangrove – BRGM*) and the Watershed Management Centre (*Badan Pengelolaan Aliran Sungai dan Hutan Lindung* – BPDAS), there is no overlap between our proposed sites and both Indonesia's NDC or govRehab locations (Figures 1, 2, 3 and 5).

To visualise the location of our proposed sites in relation to areas currently covered by the Indonesia's NDC and govRehab in a more interactive manner, please download the map files through this link: Mangrove PIN Sulawesi. This map data is best visualised in Google Earth software. If you do not have the software installed, please click here to download: Install Google Earth.

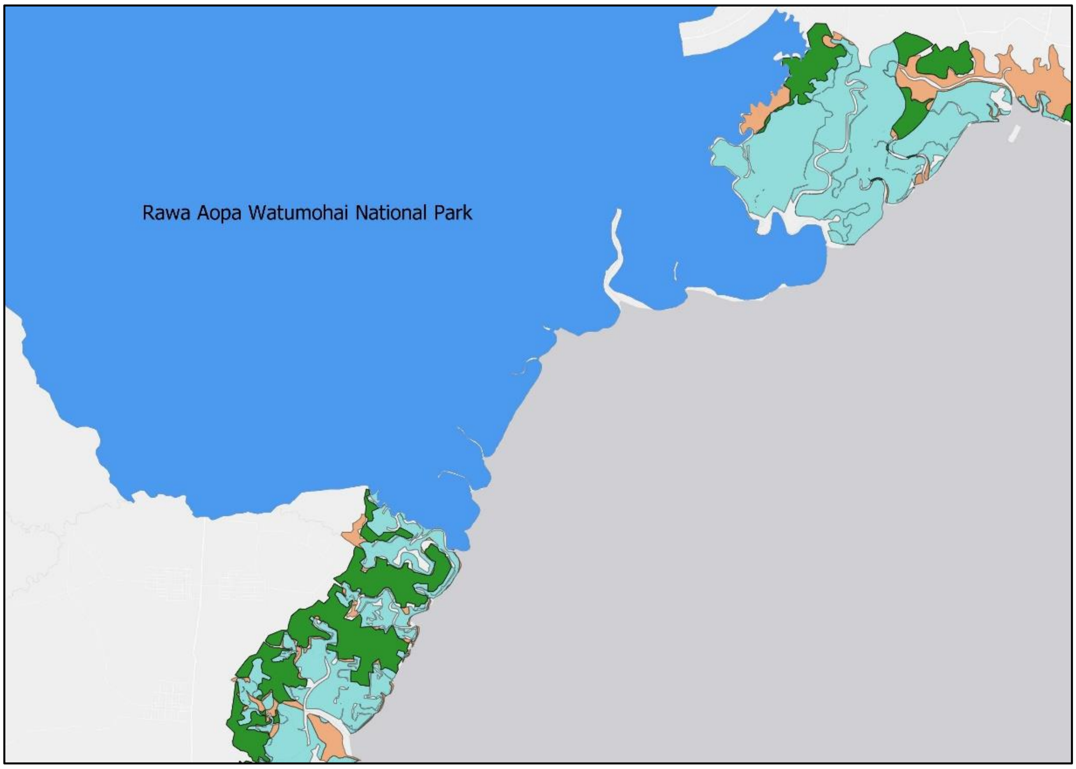


**Figure 5**. Project sites located in eastern Bombana and western Konawe Selatan regencies in Southeast Sulawesi (Green) in relation to mangrove forest inside Rawa Aopa Watumohai National Park (Dark blue), Indonesia's NDC registry (Orange) and areas already targeted for rehabilitation (govRehab) by the Indonesian government (Light Blue). There is no overlap between our proposed sites and Indonesia's NDC, govRehab or RAWNP boundaries.

## Local drivers of deforestation

Mangrove forests across Indonesia have been extensively used and degraded in the past two decades, with its total extent having decreased by 1,731.54 km$^2$ between 1996 and 2016 (Bunting et al., 2018). The three areas encompassed in this PIN project are no exception, and in Bombana and Konawe Selatan the clearance of mangrove forest has been carried out mainly for the purpose of creating fishponds, locally known as *empangs* (Figure 6). With this PIN proposal, we are aiming to address the problem of mangrove forest areas being destroyed for the purpose of creating new *empangs* (Malik et al., 2017), which are often then left unused after some years (Figure 7).

Across the island of Muna, many communities are also still heavily dependent on timber for cooking and building materials (Rahman et al., 2020), and so clearance of mangrove forest for its wood is still a normal occurrence (Figures 8, 9). After being cleared, these areas are then often left fallow or converted to *empangs* (Figure 9).

**Figure 6**. Mangrove forested area that has been converted into a fishpond (*empang*) in the village of Ranooha Raya (Moramo – Konawe Selatan regency, Southeast Sulawesi).

**Figure 7**. Abandoned fishpond (*empang*) in the village of Boeara (Poleang – Bombana, Southeast Sulawesi).

**Figure 8**. Community use of mangrove wood for firewood and building materials in the villages of Lakara Bajo (Konawe Selatan) and Lantawe (Muna island) in Southeast Sulawesi.

**Figure 9**. Mangrove forested area that has been cleared for wood in the Latawe village (Muna Barat – Muna island, Southeast Sulawesi) and left fallow.

### B2) Description of Socio-Economic Context (PV requirements 7.2.2-7.2.5)

According to the Ministry of Manpower (issued circular No. M/11/HK.04/X/2020), at provincial level in Southeast Sulawesi, the standard minimum monthly wage is currently set at 2,552,014 IRP (approximately 180 USD). However, our field social interviews in the target villages indicate that the reality is that many people live on a lower income unless they are a government civil servant employee. Coastal communities in Indonesia often consider themselves poor, due to lack of cash savings, although many have substantial capital assets (home, boat, farmland, fishponds, etc.). Many rural coastal community members, however, are genuinely poor, with incomes of less than 2 USD a day (Brown et al., 2014).

The average socio-economic context at a village level is described below, and although there is some variation in villages both within and between regencies, to a large extent similar conditions are likely to occur. Detailed information on the socio-economic context of each village that is added to the project will be incorporated into the Project Design Document.

**Average income and main types of income in the area**

The main livelihood in villages targeted by our PIN proposal across the three regencies is commercial farming with shifting cultivation techniques and aquaculture through *empangs*. Other livelihood sources include subsistence farming and fishing, some cash-crop farming (rice, cashews, cocoa, coconut), government civil service jobs (this includes teachers, nurses, doctors, police, army, government office jobs) and small trade businesses.

Our social field surveys indicate that the average income (profit) for a farmer per hectare of owned *empang* is 10,000,000 IRP (approximately 688 USD) for a three-month cycle (from introducing the seed stock to harvesting the shrimp or fish), which translates to approximately 3,500,000 IRP (240 USD) per month. However, many interviewed farmers stated that often the whole crop would fail and die (largely due to inappropriate construction methods, poor environmental conditions, overstocking and disease problems; Stevenson, 1997), leaving them nothing but the debt of the initial seed stock investment (generally 10,000,000 IRP investment per cycle). From the four cycles in a year, it is fairly common to hear that one to three ends up failing, barely allowing famers to break even or, more often than not, making a loss.

In the districts of Tinanggea in the Konawe Selatan regency and Lantari Jaya in Bombana, which contain the largest expanses of *empangs,* it was also not uncommon to hear about the existence of loan schemes, by wealthy and organised businesspeople, that highly profit from *empangs* by lending farmers the money to acquire seed stock. Due to the high likelihood of crop failure, *empang* farmers end up racking up debt each time a crop fails, and when a crop succeeds the money lenders will then keep most of the profits by collecting past debts.

In smaller villages, there is naturally less community organisation and so less cash in hand for acquiring seed stock after multiple crop cycle failures. As such, there is a higher incidence of land left unused and lying fallow, simply because farmers cannot afford to re-invest in seed stock, often then changing to other livelihood sources such as agriculture and fishing.

**Relevant local governance structures**

A village (or *Desa*) is the lowest governmental structure in Indonesia. Villages can be classified as 'common' whereby the Village Head is democratically elected every four years, or 'customary' (called *adat)* whereby village governance follows more traditional methods with respected elders and village 'elites' in control. The villages covered by this PIN proposal follow the common village type, which means governance is not based on *adat* structure.

Village government is comprised of an elected Village Head (VH) and a Secretariat (ST). The ST is led by a secretary and supported by three officers in charge of administration and public affairs, financial affairs, and village planning.

Our team will work closely with the VH and Secretary to identify fishpond owner participants in each village, to identify women and vulnerable community members to participate in the sustainable livelihood training programmes, to organise the community teams that will be working on the mangrove rehabilitation project, and to select a team to manage the village development funds. Despite these being common type villages, we predict that the Village Head will include the recognised Village Elders (*Tokoh Adat*) in these proceedings out of respect, as is still often the way of things in many villages in Southeast Sulawesi. Having their support for the project will be valuable as Village Heads are elected every 4 years and the longest that one can serve as a VH is 12 years, however with the traditional Village Elders system the status is acknowledged generally until the person dies.

**Relevant national and sub-national levels of governance structure**

Below are the government institutions above village level with responsibility for land and mangrove forest management. Names in italic inside brackets represent the organization names in the local language (Bahasa).

National level

- Directorate General of Climate Change – Ministry of Environment and Forestry (*Dewan Nasional Pengelolaan Perubahan Iklim – Kementerian Lingkungan Hidup dan Kehutanan*)

Province level (offices in Kendari City)

- Southeast Sulawesi Province Government (*Pemerintah Provinsi Sulawesi Tenggara*)
- Southeast Sulawesi Province Forestry Department *(Dinas Kehutanan Provinsi Sulawesi Tenggara*)
- Southeast Sulawesi Provincial Development Planning Agency (*Bappeda Provinsi Sulawesi Tenggara*)
- Forest Area Designation Bureau (BPKH)

Regency (*Kabupaten*) and Administrative district (*Kecamatan*) level

**Table 2**. Listing of all Administrative districts (*Kecamatan*) across Muna Island and the regencies of Bombana and Konawe Selatan in which our target villages are included. Target locations in Muna Island are spread across three different regencies (Muna – M; Muna Barat – BM; Buton Tengah – BT).

| **Bombana** | **Konawe Selatan** | **Muna island** |
|---|---|---|
| Lantari Jaya | Kolono | Kabangka (M) |
| Mata Oleo | Lainea | Kabowo (M) |
| Poleang | Moramo | Katobu (M) |
| Poleang Tengah | Palangga Selatan | Lasalepa (M) |
| Raowatu Utara | Tinanggea | Mawasangka (BT) |
| Rumbia | --- | Napano Kusambi (MB) |
| Rumbia Tengah | --- | Parigi (M) |
| --- | --- | Tiworo Utara (MB) |

# Part C: Identification of Target Groups & Communities

## C1) Summary information of participating communities expected to benefit from the project (PV requirements 1.1, 7.2.1, 7.2.7 & 7.2.8)

Total Population of Southeast Sulawesi is 2,624,875 as per 2020 census. Population Data is available by district (*Kecamatan*).

**Konawe Selatan:**

- Total Population of 308,524 as per 2020 census.
- Sub District Populations:
  - Moramo: 15,634 (made up of 21 villages/small towns and we are working with one of these: Ranooha Raya)
  - Kolono: 11,397 (made up of 21 villages/small towns and we are working with three of these: Awunio, Silea, Langgowala)
  - Lainea: 10,038 (made up of 12 villages/small towns and we are working with two: Pamandati, Lalonggombu)
  - Palangga Selatan: 7,392 (made up of 10 villages and we are working with one: Lakara)
  - Tinanggea: 24,971 (made up of 24 villages/small towns and we are working with five: Roraya, Pongosi, Asingi, Lasuai & Lapulu)

**Bombana:**

- Total Population of 150,706 as per 2020 census.
- Sub District Populations:
  - Lantari Jaya: 8,475 (made up of 9 villages/small towns and we are working with two of these: Lantari, Pasare Apua)
  - Raowatu Utara & Rumbia combined: 7,147 & 12,385 (made up of 13 villages/small towns of which we are working with four: Hukaeya, Tunas Baru, Daole, Kasipute)
  - Rumbia Tengah & Mata Oleo combined: 7,267 & 7,079 (made up of 16 villages/small towns of which we are working with four villages: Lampata, Tapuahi, Mawar, Laora)

    - Poleang & Poleang Tengah combined: 14,336 & 3,676 (made up of 15 villages/small town and we are working with four of these: Boeara, Boepinang, Paria & Mulaeno)

**Muna**

- Total Population of 215,527 as per 2020 census.
- Sub District Populations:
    - Lasalepa: 11,770 (made up of 7 villages, of which we will be working with one: Bonea)
    - Katobu: 29,900 (made up of 8 urban villages, of which we will be working with one: 'Pelabuhan Muna')
    - Parigi: 13,110 (made up of 11 villages/small towns, of which we will be working with one: Labulubulu)
    - Kabangka: 10,560 (made up of 10 villages, of which we will be working with one: Oensuli)
    - Kabowo: 13,920 (made up of 11 villages, of which we will be working with one: Kawite-wite)

**Muna Barat**

- Total Population of 84,590 as per 2020 census.
- Sub District Populations:
    - Napano Kusambi: 5,538 (made up of 6 villages, of which we will be working with one: Lantawe)
    - Tiworo Utara: 5,686 (made up of 7 villages, of which we will be working with one: Tondasi)

**Buton Tengah**

- Total Population of 114,773 as per 2020 census.
- Sub District Populations:
    - Mawasangka: 28,985 (made up of 19 villages/small towns, of which we will be working with one: Tanailandu)

## Poverty Indicators

**Table 3**. Indicators of poverty in the target Regencies in Southeast Sulawesi. (%) represents the percentage of the total population in the regency, H% the percentage of households in the regency. Poverty Line indicates the amount that an individual lives on.

| Regency | People living in poverty (%) | Families living in poverty | Poverty Line | H% using wood as main cooking fuel | H% with no access to bathroom facilities | H% with adequate access to clean drinking water | H% in houses with earth/sand floors |
|---|---|---|---|---|---|---|---|
| Konawe Selatan | 33,890 (10.81%) | 16,262 | Less than 60 cents/day | 18.91% | 11.41% | 73.8% | 3.29% |
| Bombana | No data (10.01%) | 7,365 | Less than 76 cents/day | 9.38% | 12.15% | 82.75% | 1.05% |
| Muna | 28,730 (12.83%) | 12,336 | Less than 84 cents/day | 46.1% | 14.84% | 71.22% | 2.31% |
| Muna Barat | 11,320 (13.3%) | 4,660 | Less than 84 cents/day | 64.66% | 14.58% | 68.35% | 2.29% |
| Buton Tengah | 14,400 (15.32%) | 8,877 | Less than 62 cents/day | 25.77% | 11.62% | 77.16% | 2.52% |

Sources: Cooking Fuel; Bathroom Facilities; Access to clean drinking water; Families living in poverty

We will be working in the 3 main regions of Konawe Selatan Regency, Bombana Regency, and Muna Island. Muna Island is made up of 3 small regencies; Muna, Muna Barat and Buton Tengah, and as we will be working with small groups of people in each of these 3 regencies, for the sake of this proposal we are referring to the area as Muna Island.

Each of our areas is home to a different ethnic group. The fishpond owners of the Bombana regency are predominantly Bugis in ethnicity, the people of Konawe Selatan are predominantly Tolaki, and the people of Muna Island are the traditional Muna people. There is some mixing of these three ethnic groups in each area, with a few other ethnic groups such as Buton, Javanese, Balinese and sea nomad Bajo people scattered throughout the area, but mainly the three predominant groups are split by the above-mentioned geographic areas.

The Bugis are the third largest ethnic group in Indonesia. They are a dynamic and highly mobile seafaring group originating from South Sulawesi and now can be found inhabiting all coastal areas in Sulawesi and spread throughout Indonesia as a whole. This tribe has a very rich culture, is known for trade, a history of fierce piracy, and is said to be where the children's legend 'the bogey man' originates from. These people are generally seen as being strong and more prosperous than the indigenous tribes of the area, and indeed moved to Southeast Sulawesi for the purpose of exploiting the natural resources for farming and fishery related businesses. Table 2 shows that the people of Bombana have lower poverty indicators compared with those in our other areas which is to be expected.

The Tolaki are one of the main indigenous ethnic groups on mainland Southeast Sulawesi and the Muna people are the main indigenous group on Muna Island. Both the Tolaki and Muna groups are heavily reliant on agriculture-based livelihoods, and fishery related activities are also prevalent here. The Tolaki people are known to embrace the concept of a simple life and generally practice simple non-irrigation type farming, though in our areas many have copied the Bugis fish farming methods with varying levels of success. The same can be said for the people of Muna.

In terms of prosperity the indigenous groups have a lower socio-economic status compared to the Bugis, with the Muna people struggling the most. The Tolaki have more opportunities and better infrastructure given their closer proximity to Kendari, the capital city of Southeast Sulawesi, however Muna being an island is more isolated and a drive through some villages on the island quickly shows that it lags developmentally compared to the regencies on mainland Southeast Sulawesi. Table 2 showing the poverty indicator statistics for each area also highlights this disparity.

Aside from these three main ethnic groups, some of the villages we will be working with have predominantly Bajo residents whom are a marginalised ethnic group in Indonesia, due to their relatively recent shift from a nomadic seafaring life to that of a settled people. Subsequently the literacy rates and educational attainment in these villages is significantly lower compared with the local land-based villages, and this has an evident economic impact on the communities. Three Bajo villages are being considered for this project; Lakara Bajo in Konawe Selatan, and the villages of Kawite-wite and Lantawe on Muna Island.

### Gender and age equity

Most empang owners/workers are adult males, however in Indonesia a landowner must have their spouse sign any official paperwork such as sale or lease of land documents, so the empang owners' wives will be acknowledged and included in any contracts made and will likely be the ones receiving the payments from the Yayasan in many cases. In this area of Indonesia, it is seen as proper that the woman of the house manages the finances. Traditionally a ‘good husband’ is expected to give all his earnings to his wife, who then manages the finances for the good of the family and gives the husband ‘pocket money’ with which to buy cigarettes etc. In practice this is not always the case, but many acknowledge this as the ‘proper way of doing things’ so Yayasan facilitators will set this expectation for involving the wives from the beginning.

The project will also endeavour to include women and people of low socio-economic status in the village in all capacity building training workshops and in the village committee that will manage the development fund and micro-finance aspect of the project. An emphasis will also be placed on recruiting a balance of male and female labourers to be involved in the mangrove rehabilitation and planting teams.

## Part D: Land Tenure & Carbon/ES Rights

### D1) Description of land tenure context and current understanding of carbon/ES rights for the project area(s) (PV requirements 1.1 & 1.2)

This project will be working directly with individual and/or communal landowners within each village. Each village has to be designated on the BPKH zonation map as having the rights to the areas being targeted. Individual farmers within these areas targeted by this PIN proposal must have a recognized legal claim to the land, which ideally will be in the form of a Land Certificate (*Sertifikat Tanah*; Figure 10) issued by and registered with the National Land Registry (*Badan Pertanahan Nasional* – BPN). The first stage of this process is where the Kepala Desa (Village Head) confirms that the neighbours of the claimant agree the boundaries of the land. A *Kompensasi Tanah*, is then issued by the relevant administrative district office stating that the local government and neighbouring landowners recognise the individual as the legal landowner. However, due to the high cost and lengthy bureaucracy to the landowner(s) in converting a *Kompensasi Tanah to a Setifikat Tanah* many farmers stop at the *Kompensasi Tanah* stage.


Figure 10. Examples of a Land Certificates (*Sertifikat Tanah*) issued by the National Land Registry (Badan Pertanahan Nasional).

For those farmers being offered the long term lease or the eco-empang options, then a *Kompensasi Tanah* will be accepted, but for those where purchase is the option then a Land certificate will be applied for.

Most of the empang owners have three (approximately 3ha) and occasionally more empangs. The larger farmers can usually never afford to farm all the ponds – they are asset rich but cash poor.

The major area of conflict is the battle between villages who are wanting to expand their village land into mangroves and the Ministry of Environment and Forestry (MoFE) who want to retain the state forests intact and include them in their Nationally Determined Contribution (NDC) map. Many of these state forest areas in SE Sulawesi have been cleared illegally by local communities and the MoFE has set a target 6,000 ha mangrove rehabilitation in 22 provinces during 2021-2024. This reforestation work will be conducted by BPDAS (MoEF's) technical implementing unit at province level) in 22 provinces. This reforestation though is targeted only at state forests and is being funded to help local communities to have some income to help with Covid recovery, from the mangrove restoration work. There are, however, no funds available for long term maintenance of these replanted areas or development of additional sustainable income streams to ensure the restored mangroves remain intact. The proposed project which is on land NOT included in state forest should be complementary to the BPDAS activity and there is no overlap in areas targeted.

In addition, BRGM (as a new national agency on mangrove restoration), has set a target of 600,000ha of mangrove rehabilitation during 2021-2024 in 9 provinces (North Sumatra, Riau, Riau Islands, Bangka Belitung, West Kalimantan, East Kalimantan, North Kalimantan, Papua and West Papua). Southeast Sulawesi is not included in this initiative.

In Indonesia all projects proposing to issue carbon credits need to register at the System Registrasi National and on completion of the PIN, this project will be registered. In addition, the document will be sent to the Governor of SE Sulawesi, so that he can see the benefits to local communities (64% of the income as outlined in section L is paid to the communities and 85% is spent in SE Sulawesi).

The Governor is very keen on implementing projects that help impoverished local communities and there is considerable power at provincial level. In the end the Directorate General of Climate Change (DJPPI - Direktorat Jenderal Pengendalian Perubahan Iklim) will issue the document that authorises the project to proceed.

## Part E: Project Interventions & Activities

### E1) Description of the types of interventions included in the project and envisaged to generate PV Certificates (PV requirements 2.1.1-2.1.4), e.g.:

**Option 1: Purchase of Land (40%)**

The owners will be offered Rp35 million per ha for an outright sale of the land to Yayasan Bunga Bakau Indonesia. On completion of the transfer the Yayasan will complete major hydrological adjustments across the whole area, and mangrove planting using propagules of species in the adjacent mangrove areas. In addition, mud crabs and/or bees will be introduced to enable all village members to potentially benefit from sustainable non-timber mangrove utilisation. Annual contributions (paid as 2 payments 6-months apart) to the village development fund, (equivalent to Rp1 million per ha in years 2 – 25), will be made in exchange for a village wide commitment to take care of the Yayasan owned mangrove area and not engage in any mangrove logging activities in that area. How each community will utilise the annual payments will be agreed with the community before each payment. The payments might take the form of micro-finance loans for community members to develop businesses, training in how to develop businesses such as honey or mud crabs, or community benefits such as development of clean water supplies, schools or communal meeting areas. Note funds will not be paid until there is agreement at village level on how the funds will be used for general community benefit. After the 25-year period the Yayasan is committed to maintaining the land in its natural mangrove state in perpetuity.

**Option 2: Leasing the land for 25 years (40%)**

The owners will be offered Rp20 million per ha to agree a 25-year lease of the land. On signing the lease, the Yayasan will complete major hydrological adjustments and mangrove planting across the whole leased area using propagules from adjacent intact mangroves. In addition, the Yayasan will introduce bees and/or mud crabs and train the owner in how to benefit from these activities. Annual contributions (paid as 2 payments 6–months apart) to the village development fund, (equivalent to Rp1 million per ha in years 2 – 25), will be made in exchange for a village wide commitment to take care of the Yayasan owned mangrove area and not engage in any mangrove logging activities in that area. How each community will utilise the annual payments will be agreed with the community before each payment. The payments might take the form of micro-finance loans for community members to develop businesses, training in how to develop businesses such as honey or mud crabs, or community benefits such as development of clean water supplies, schools or communal meeting areas. Note funds will not be paid until there is agreement at village level on how the funds will be used for general community benefit.

**Option 3: Eco-empang (20%)**

This option will start with a 25-year legal agreement with the empang owner who will receive an initial Rp4 million fee. A further Rp12 million will then be paid to convert the empang into an eco-empang (Figure 11). This will involve opening up gaps in the walls surrounding the empang so that the pond is well connected to tidal flows and to enable the centre part of the pond to dry out at low tide. The channels around the inside edge of the empang are deeper since material was dug from these areas to create the walls of the pond, so water would be retained in these deeper areas even at low tide. Mesh filters will be installed in the empang gaps so that shrimp or fish in the remaining channels are retained in the empang. The central part of the empang will then be planted with mangroves using propagules from adjacent areas of mangroves. This means that for every hectare of fish pond, approximately 50% will be converted into mangrove. Once the eco-empang is constructed and the mangroves planted in the central area, the owners will be given Rp2 million a year in subsidies from years 2 – 5, followed by Rp1 million per year in years 6-25, to run a sustainable shrimp farm which will need less inputs since the shrimp will be able to feed amongst the mangroves at high tides. The owner has to commit to ensuring the mangroves remain intact throughout the 25 year period.

**Figure 11** Illustration of what an eco-empang would look like at low tide. Mangrove trees will be planted both in the central portion and the intertidal range all around the outer edges.

### Community Benefits

All options result in an increase in mangrove adjacent to the villages, improving the community resilience to tidal surges, boosting fishing and harvesting within and adjacent to mangroves (zu Ermgassen et al., 2021), as well as improving coastal fisheries because of increased nursery areas and improving water quality in the remaining fish ponds owned by members of the village (Sadono et al., 2020). Under options 1 and 2, the wider community also receive financial benefits for the full 25 years for ensuring that the mangroves areas replanted remain intact.

Yayasan Bunga Bakau Indonesia will provide paid employment for each 700ha of restored mangrove for a total of 20 community organisers, 2 from each district for a period of approximately 1.5 years to assist with the logistics of the mangrove rehabilitation process. The Yayasan will provide paid employment for a period of 5 years to at least 5 local project staff members working full time on the project. The Yayasan will spend the operations budget on things such as vehicle purchase or rental, fuel, local accommodation expenses and other incidentals, which will further benefit the wider economy of SE Sulawesi.

## Part F: Identification of Any Non-Eligible Activities

### F1) Description of additional activities to be supported and / or implemented by the project

Training will be offered by Yayasan Bunga Bakau Indonesia to help the villages to decide how to organise their own system for allocating the use of funds going into the village development fund. For example, the Yayasan project organisers will identify options for training, including: understanding the ecological value of mangroves, and their help in community resilience against climate change, how to develop sustainable mangrove livelihood options including mangrove bee keeping, mud crab fattening, setting up and operating eco-empangs, and utilisation of micro-finance loans to establish local businesses etc. These training sessions funded from the community development funds would require that women form at least 50% of the attendees and people with the lowest socio-economic status in the village are represented. The Yayasan project manager for the village will encourage the community to support spending the community funds on kickstarting the sustainable livelihood options of interest to the particular village, although other options such as help for the local school, medical centre, meeting location or water supplies will also be considered. The village will make the final decision on how they can best utilise the funds provided over the 25 years from the community payments.

## Part G: Long-Term Sustainability Drivers

### G1) Description of project design that will ensure the project is self-sustaining after carbon/PES revenues cease

Yayasan Bunga Bakau Indonesia (YBBI) is committed to maintaining the mangroves on the land owned by the Yayasan in perpetuity. At the end of the 25-year period, the mangroves will still not be at their maximum carbon storage. There will still be additional growth in Above Ground Biomass (AGB) and Below Ground Biomass (BGB) and sequestration in the sediment will continue. The proposal would be for YBBI to submit a second project to Plan Vivo for the years 25 – 50 and the credits would be directly sold from the Yayasan to the market at a higher rate, since these would be much fewer than for the original proposal. This would provide ongoing income for the project to continue with village payments and protection of the mangroves.

The remaining eco-empang sites should be generating more income than from traditional empangs if managed properly, so there will be pressure to maintain them.

The continuing work with the communities on education about the value of the mangrove and the development of small businesses or community facilities over the 25 years from the mangrove generated income, should by then have changed attitudes in the local communities towards protecting mangroves. In addition, the annual Opwall funded biodiversity surveys in the reforested areas will produce some income for the communities from the scientists and students who will be based in their areas for short periods each year to gather the data required. These surveys will continue long after the first 25-year project has finished.

# Part H: Application Organisation & Proposed Governance Structure

## H1) Project Organisational Structure (PV requirements 3.1-3.6)

The key collaboration in the project will be between Yayasan Bunga Bakau Indonesia who will implement the project, and rePLANET who will provide the finance and funding.

Yayasan Bunga Bakau Indonesia is a newly formed Yayasan specifically and only to implement this project (Figure 12). The reason this has been done is to reduce the risk of leakage from one project to another if the operator is running multiple projects and there is temptation to cross fund an underperforming project. A Yayasan is a not-for-profit Foundation in Indonesia and the founder members are all long-term partners or are known to the directors of rePLANET (see below) and Operation Wallacea (see below), which has been operating in SE Sulawesi since 1995.

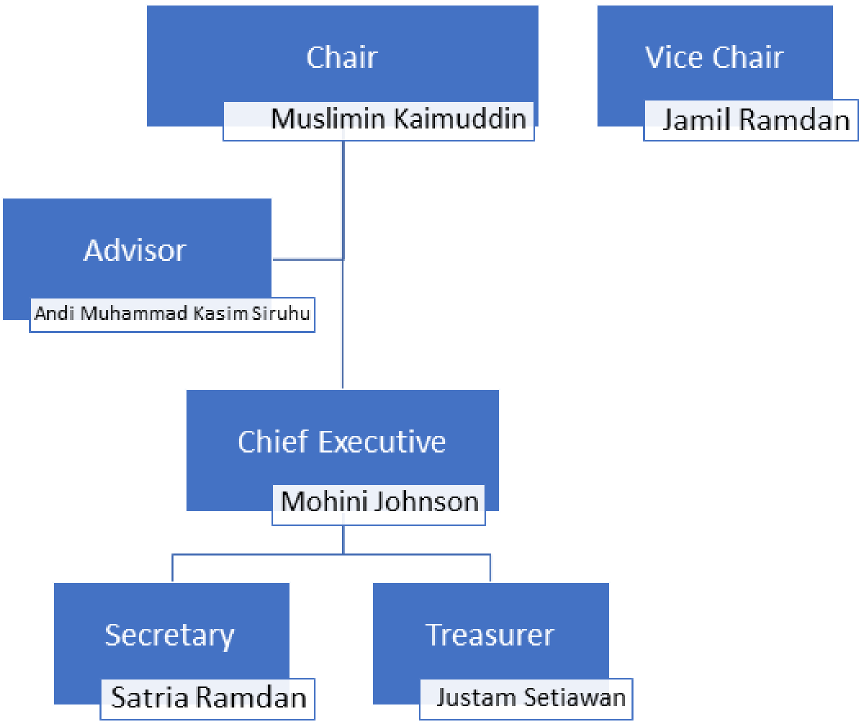


Figure 12. Management structure of Yayasan Bunga Bakau Indonesia

**Governing Board Members**

**Chair** – Muslimin Kaimuddin (Imin)

Imin has worked with Operation Wallacea for over 10 years and has experience working in Sulawesi NGO's on a range of projects. Imin is married to Mohini Johnson (Mo), has good English skills and runs his own dive and moringa businesses. Imin was brought up in the mainland areas being targeted for reforestation and has a good understanding of the local communities, and the local dialects. With strong interpersonal skills, a can-do attitude, and being adept at problem solving, he has the skills to build trusting partnerships with the village communities, coordinate the teams on the ground, and effectively see this project through to fruition.

**Vice-Chair** – Jamil Ramdan

Jamil is an environmental science graduate and local government environment department employee. Jamil will not be working on the project other than being involved in the board meetings, due to his full-time job as a civil servant. His knowledge of the workings of local government, and inside knowledge of new government interests and directives will be useful to the project.

**Supervisory Board Members**

**Advisor** – Andi Muhammad Kasim Siruhu (Pak Kasim)

Pak Kasim is a Notary and Land Deed Official and has been running his own legal firm since 1988 in Southeast Sulawesi but will be retiring in 2022. He has 30+ years experience and is legally qualified to conduct real estate transfers, issue land deeds and contracts, and notarize documents. Pak Kasim also owns a number of other local businesses, speaks some English and has been involved in many projects concerning developing infrastructure and improving livelihoods in local communities. His supervisory role and in-depth understanding of the laws and bureaucratic processes surrounding the sale and lease of property in

Southeast Sulawesi and Indonesia as a whole, will contribute significantly to the success of the project.

**Executive Board Members**

**Chief Executive** – Mohini Johnson (Mo)

Mo has worked with Operation Wallacea for over 10 years and has a degree in Environmental Science & Management from Lancaster University. She is a permanent resident in Indonesia and has lived in Southeast Sulawesi for 12 years. Mo is fluent in Indonesian, runs her own dive and moringa businesses with Imin, and has experience in project management, budgeting, staff recruitment, sales, and marketing. Her strong leadership skills and sharp attention to detail will be paramount in ensuring that the project meets targets, stays within budgets, and produces the required reports.

**Secretary** – Satria Ramdan

Satria has worked as a senior administrator in local Notary and Land Deed Office for 9 years. His specialised administrative skills will ensure that the administrative side of the project is organised and operating within the law on land tenure and contractual issues. He will be responsible for ensuring that all contracts made between the Yayasan and empang owners are legal and viable.

**Treasurer** – Justam Setiawan

Justam is an underwater archaeology graduate from UNHAS university, professional scuba diver and environmentalist. Has been involved in underwater archaeology research, marine biology research, PADI Dive Master work, and government projects concerning the preservation of cultural heritage sites in South Sulawesi. He has leadership skills, shows creativity and initiative, and his strengths are in team work and critical analysis of problems. He will be working as one of the project officers, coordinating with community leaders, identifying participants, and organising the field teams to ensure that the hydrological adjustments and mangrove planting happen on schedule. He will be working closely with Imin, a second project officer, and the community organisers that will be recruited for this project. The project will employ a qualified accountant to ensure that the financial records are kept in order.

**H2) Applicant organisation (not necessarily the project coordinator) must provide the following information about itself:**

The applicant organisation for delivery of the project in Indonesia and receipt of the carbon credits will be Yayasan Bunga Bakau Indonesia (see above).

The funding for the PIN and responsibility for future funding of the project is from a newly formed UK company (company number 13335875) called rePLANET. The purpose of this new company is to fund the development of mangrove restoration around the world using private sector funding via the voluntary carbon markets. The company has invested in the development of PINs in several countries including Indonesia.

Funding to implement the projects will be generated from the sale of carbon credits to companies that have Net Zero Carbon targets. rePLANET as part of their Memorandum and Articles have agreed to not distribute any dividends for at least the first 3 years so that any profits generated will be focussed on funding additional reforestation projects with at least 60% of all funding for each project supported targeted at supporting impoverished local communities in developing countries.

The Directors of rePLANET bring the following relevant skills and experience to rePLANET:

**Dr Mathis Wackernagel**

Mathis co-created the Ecological Footprint in the early 1990s with his Ph.D. advisor Prof. Rees at the University of British Columbia. Now he is President of **Global Footprint Network** which he founded in 2003 with Susan Burns. Mathis' awards include the 2018 World Sustainability Award, the 2015 IAIA Global Environment Award, the 2012 Blue Planet Prize, the 2012 Binding-Prize for Nature Conservation, the 2012 Kenneth E. Boulding Memorial Award, the 2011 Zayed International Prize for the Environment, an honorary doctorate from the University of Berne, and the 2007 Skoll Award for Social Entrepreneurship.

**Louis de Montpellier**

With an extensive experience in international finance with senior roles in both public finance and the investment banking world, Louis de Montpellier is an expert in the management of government and public sector debt and sovereign wealth, ESG, impact and green finance and sustainable economics. He presently serves as an independent board member and senior advisor of several financial firms and think tanks engaged in sustainable economics and impact finance, including de Pury Pictet Turrettini & Cie in Geneva; Millenium Associates AG in Zurich; GVE in Tokyo; the Official Monetary and Financial Institutions Forum (OMFIF) in London; and the global platform Finance for Biodiversity (F4B). His previous roles include Senior Managing Director and global head of the official institutions group of State Street Global Advisors in London till 2019; Deputy Head of the Banking Department and member of the Executive and Finance Committees of the Bank for International Settlements in Basel; Executive Director of the Belgian Government Debt Agency in Brussels and Director of Funding at the European Bank for Reconstruction and Development in London. He has also worked for the investment banks Credit Suisse First Boston and Morgan Stanley in London where he was responsible for capital market operations with public sector entities in Europe. Louis holds a Master of Law from the University of Leuven (Belgium), a Master of Arts in Economics from the University of Louvain (Belgium) and a Master of Business Administration from the Johnson Graduate School of Management, Cornell University (United States). He has recently followed the Board Director Certification of the International Institute for Management Development, IMD Business School, Lausanne (Switzerland). He speaks English, French and Dutch fluently.

**Bernard Yong**

Bernard is a corporate strategist with experience in engaging policy and driving growth especially in emerging markets. With a background as a capital markets lawyer with US law firm Baker & McKenzie and in public international law at the United Nations and UN-HABITAT, Bernard is interested in driving the highest impact at the crossroads straddling policy and business, and has worked across the US, UK, Asia, and Africa. Bernard is currently an Asia Pacific business strategist for Amazon Web Services based in Singapore. Prior to that, he was the Asia Pacific policy and strategy lead for RICS, a global professional body and think tank for the built environment sector. Bernard holds an LLB and LLM from the Australian National University, and an MBA from INSEAD.

**Isabel Hoffman**

Isabel specialises in the capitals approach, enabling businesses to include the value of natural, social and human capital in their decision-making. She leads the work on oceans and is part of the food system transformation team at the Capitals Coalition. Isabel represents the equity investors of rePLANET and brings a business perspective, a strong network of contacts in European and US businesses that are interested in helping with reforestation projects.

**Dr Tim Coles O.B.E.**

Tim founded and is CEO of Operation Wallacea that provides a method for funding long term biodiversity research using tuition fees paid by students. Opwall has operated as a commercial business for 25 years and established reliable working partners in a series of countries around the world. It is these contacts including those at govt level that are being used to develop the potential mangrove reforestation projects for funding. Opwall has spent 25 years building small businesses in places such as Indonesia to deliver the research programmes they deliver. The Opwall teams have published over 560 papers in peer reviewed journals from their research programmes and have manged large scale projects overseas for the World Bank, Darwin Initiative and GEF. Tim also founded the Wallacea Trust that works on a series of conservation projects around the world based on the principle of incentivising individuals or local communities to achieve the desired conservation outcomes.

**Alex Tozer**

Alex is Chief Operations Officer for Operation Wallacea and overseas the operations and safety for the research programmes involving 3000+ people in a series of remote sites in 15 countries over an 8-week period each year. Alex also directs the finance team and specialises in resource allocation, financial management and project appraisal. He has extensive experience of working with international partners and stakeholders in developing countries.

In addition to these two principal organisations there are three others that will provide support for the project:

**Oxford University Long-term Ecology Lab**

This organisation is expert at handling large data sets and developing databases and visualisation of these data sets. They have previously developed schemes to help identify the areas to minimise impacts on biodiversity (LEFT) and also to quantify ecosystem services. Their role will be to develop an online database that will contain data on each of the hectares in the scheme and which can be publicly accessed by stakeholders and interested parties online. This is to provide greater transparency of the project than can be achieved from 5-yearly audits and means that any purchaser of credits can be identified as the owner on the relevant website page for each of their hectares and they can monitor progress for themselves.

**Operation Wallacea**

Operation Wallacea runs annual biodiversity research in SE Sulawesi each June – August period using international and national academics funded by the tuition fees paid by the accompanying students. These data will be provided free of charge to the project each year by the Opwall teams.

**Wallacea Trust**

This is a UK registered charity that supports the development of business solutions to environmental challenges and has a strong group of Trustees drawn from academic, business and NGO backgrounds. Their role will be to act as auditors on a quarterly basis by grilling the rePLANET staff member responsible for the project to identify any weak spots in the project and advise on how to resolve any issues identified.

Once the project is at the implementation stage (see section L) then the roles will be split between the Yayasan Bunga Bakau Indonesia and rePLANET as follows:

**Yayasan Bunga Bakau Indonesia (YBBI)**

- To organise the sampling for the coring both in the planted and control areas and to ensure that the cores are analysed using the required methodology at a reputable laboratory in Indonesia. These data to be provided to rePLANET.
- To register the carbon project with the Indonesian SRN.
- To set the budget for the project and agree an issue price that rePLANET will purchase the credits at, based on this budget.
- To set the necessary payment schedule for the project based on the budget.
- To transfer the carbon credits to rePLANET.
- To obtain all necessary support letters including confirmation from PPI that the project can be issued with the carbon rights.
- To manage the funds provided by rePLANET including agreeing contracts with the farmers, planting the land, and making the agreed biannual payments to farmers and the communities.
- To ensure copies of all farmer agreements are lodged with rePLANET and originals filed safely with the legal representative.
- To staff the project so there are adequate YBBI staff in the target communities to ensure there is full consultation over the ways in which the funds provided to the communities could be most effectively spent.
- To organise training of local community members in alternative income streams and also in the possibilities of micro-finance loans to develop additional businesses.
- To ensure the planting is achieved at the required density of propagules and that 6-monthly checks of each planted area are made with photographs taken prior to release of payments to the communities or if an eco-empang, to the individual farmer.
- To report to rePLANET on a weekly basis on progress with the project and providing monthly accounts of expenditure to rePLANET to audit.
- To provide socio-economic data of beneficiary farmers and their dependents to rePLANET and to report on progress with training and how the various communities are utilising the community funds.

- To ensure that photographs of each hectare of planting with GPS location data and date taken are provided to rePLANET each 6 months.
- To resolve any disputes that arise during the project from farmers or communities.
- To ensure the relevant local authorities are kept fully informed of progress with the project.
- To ensure that any local taxes arising from the project are paid in full.

**rePLANET**

- To provide the technical support needed to complete the PDD and estimate the likely carbon sequestration over the next 25 years using the approach outlined in Appendix 1.
- To assist Plan Vivo with their on-site audit and any follow up information required.
- To finance and fund the project by paying YBBI in accordance with the agreed budget and payment schedule in exchange for receipt of the carbon credits.
- To register the onward sale of any credits with Plan Vivo.
- To monitor progress on a weekly basis during the establishment phase of the project and to prepare monthly reports for the Board and Plan Vivo on progress.
- To ensure that a contract is placed and implemented with Oxford University Long-term Ecology lab to produce a website that has publicly accessible data (photo, ownership, estimated carbon levels) for each hectare. To update data on each hectare each 6 months with updated photos and tree data.
- To liaise with Opwall to ensure that they include biodiversity surveys on the replanted areas in their annual biodiversity survey of areas of SE Sulawesi. The biodiversity data to be included in reports to Plan Vivo.
- To discuss the project in depth and provide written reports to the Wallacea Trust so the Trustees can identify any issues on progress with the project. This is designed to be a 2-hour viva on a quarterly basis by the Trustees

of the rePLANET official in charge of the project to identify any weak points with the project. A copy of the Minutes of this examination to be provided to Plan Vivo.

## Part I: Community-Led Design Plan

### I1) Plan for achieving community participation in the project, including a mechanism for ongoing consultation with target groups and producers (PV requirement 4.1)

The whole project has been designed from the start with community consultation. It started with Imin (proposed Chair for Yayasan Bunga Bakau Indonesia) completing a 9-day intensive survey covering the whole area to identify potential area for mangrove rehabilitation, and to ground truth initial satellite imagery that had identified areas of mangrove loss. GPS Points were collected, photos taken at each location, and information about the surrounding villages was collected. During this week, Imin gained an understanding of the problems faced by empang owners, and learnt that many empangs are unused or abandoned. He learnt about the frequency of crop failures being as high as 3 out of 4 harvest cycles in some areas and that crop failures arise due to poor water quality and water temperature issues, due to poor water flow, and lack of oxygen in the water. Many empang owners complained of a lack of fertiliser and attributed that as the reason that their shrimp crops die. In some areas they talked about a lack of financial capital, meaning that there was no money to buy seed stock, so the empangs lay fallow as a result. Some farmers told of how they had suffered so many lost crops that they have given up and returned to other livelihood means such as farming or fishing. This initial survey gave rise to the idea of targeting disused empangs as the potential area for rehabilitating mangrove. It also gave rise to the eco-empang concept as Imin could see that communities were not so enthusiastic about the environmental benefits of replanting mangroves. However, when he spoke to them about finding ways to replant mangroves and use their empangs for sustainable livelihood purposes, which would not require much financial input on their behalf, there was a lot of enthusiasm. Many community members lamented clearing all the mangroves in the first place and talked of the good old days when they could go out and catch large mud crabs and mangrove shrimp in the mangroves surrounding their homes.

A second 8-day survey was carried out across the Regencies of Bombana and Konawe Selatan, in which 22 village Heads were interviewed. Twenty one of these were male leaders and only one was a female village leader. The survey asked questions relating to number of village residents involved in fishpond farming, area of fishponds in hectares belonging to residents of the village, the type of fish or shrimp farming most common, the success of empangs as a livelihood and estimate income values, the problems faced by empang owners, estimates of the area of fishponds not being used and the reasons why, whether there were outside investors involved in fishpond farming in the village, whether the fishpond owners had legal claim to the land their fishponds are located on through land certificates or kompensasi tanah, whether fishponds were often bought and sold and estimate prices per hectare if so, and questions about other livelihood income streams common in the village. The subsidised eco-empang and mud crab cultivation concept was also raised to gauge interest levels. All apart from 1 village head showed great interest in this idea. A number of Head Men were identified as being extremely supportive of a project such as this, and they actively followed up with phone calls after the meeting asking for more information and when such a programme could begin in their village.

After the second field visit was completed, the Yayasan team created 3 options for implementing the project (see section E1). The aim was to find solutions that would enable this project to rehabilitate mangrove whilst maximising benefits to the local communities upon whose land the mangroves would be planted. To road test the feasibility of the proposed solutions, Imin returned to three villages in Konawe Selatan (Awunio, Roraya and Rano Haraya) to introduce the options and talk through the viability of the compensation figures with the village head men in these three villages. All three headmen welcomed the options put forward and each called a further meeting where Imin was able to present to a small group of empang owners (approx. 10 people attended in each village). The Eco-empang idea was greeted warmly, the land purchase option was regarded warily, though after the meetings in 2 cases, phone calls were received within a couple of days with the offer to buy some empangs in the village right away. The leasing option was not greeted so enthusiastically, so that was reworked with a larger sum up front to make that a more attractive option, based on feedback from the empang owners during those meetings. The pricing structure for option 2 should now be well received and it is thought that around 80% of the farmers will choose options 1 or 2. Option 2 has the facility for the farmer to upgrade to a full sale (if the full 40% of sales has not been achieved), so it is likely that this option will be selected by many in the first instance and then changed to a full sale at a later date.

This same approach of meeting with communities will be used to determine their interests over how the community funds should be utilised, with concentration on projects that would help develop businesses in the communities, or on shared facilities (e.g. schools, medical centres etc). An initial visit would be used to gauge areas of interest, followed by a second visit to each community to suggest a series of costed options for the communities to choose from.

## Part J: Additionality Analysis

### J1) Description of how project activities are additional (PV requirement 5.4)

Additionality for this project is determined by what would happen to the disused or under-used fishponds in the event of the project not proceeding. There is no sign at any of the sites that the sites will be abandoned and allowed to return to mangrove since there has been significant investment by the farmers and it is their land. The likely scenario is that they will continue to be used from time to time but not add significantly to the farmers' income. The response on alternative income streams from the village consultations supports that assertion and there were no examples of mangroves reclaiming any fishponds in the areas investigated.

So, the alternative is whether there are plans to reforest any of these areas. Imin has met with the following govt officials in the provincial capital, Kendari.

- Pak Yuliard, Kepala Bidang Rehabilitasi Hutan Lahan (RHL): Head of Forest and Land Rehabilitation Section.
- Pak Apep, Kepala Bidang Penelolaan Daerah Aliran Sungai (PDAS): Head of Watershed Management Section.
- Pak Dedi Barelaku, Kepala Badan Pengelolaan Aliran Sungai dan Hutan Lindung (BPDAS): Head of Watershed Management and Protected Forest Implementation Unit.
- Pak Edy Bambang, Kepala Balai Pemantapan Kawasan Hutan (BPKH): Head of Forestry Boundaries Agency

The above officials were told about the concept of the project and all were very welcoming and supportive. A formal letter was requested in order for them to provide us with their map outlining the 'Protected Forest' zones throughout our targeted area, and they quickly provided us with the required information. Pak Edy Bambang was extremely supportive of the project concept and confirmed that in SE Sulawesi, rehabilitating mangroves in privately owned empangs is outside of the government capacity, due to the complication of having private landowners involved and the size of the budgets needed to adequately compensate them. In addition, they already have thousands of hectares of illegally cleared govt land on which to concentrate any mangrove rehabilitation funds they have. The proposed project would be a test for how other areas of privately owned disused or under-utilised empangs could be reforested with the local communities getting the benefits.

## Part K: Notification of Relevant Bodies & Regulations

### K1) Provide both of the following (scanned copy of letter, or email):

Appendix 2 contains a letter and translation from the Head of BPKH (department dealing with mapping of different land uses) confirming that all the areas being targeted are outside the Indonesian NDC and any plans for reforesting mangroves from govt departments.

Appendix 3 contains a letter from Yayasan Bunga Bakau confirming that they will abide by all national and international regulations.

## Part L: Identification of Start-Up Funding

### L1) Details of how the project will be financed in the development phase, before full project registration

The project is being funded by rePLANET in the following stages:

Stage 1 – this is completion of the PIN with detailed budgets for how the project will be implemented. The PINs are being produced by internal staff of rePLANET and the in-field partners and the budgets represent the total costs of the project. At this stage, the amount of carbon that will be certified as part of the scheme is unknown, although the total costs can be modelled against a range of carbon values to determine the likely range of costs.

Stage 2 - this is producing the Project Development Document (PDD) which will involve modelling the predicted Above Ground Biomass, Below Ground Biomass and rates of carbon accumulation in the sediment. However, it will also involve 2m coring of the sediments (see Appendix 1) in replicate ponds to be reforested taking into account variables such as time since clearance (grouped into 5-year blocks), and original position within the mangroves (carbon sediment is not uniformly distributed across mangroves from the land to the sea edges) to determine the remaining carbon that is in the sediment into which the propagules will be planted. However, whilst carbon levels will continue to decline in fish ponds it cannot be assumed that these levels would fall to zero, so coring will need to be undertaken in a series of control site sites that were converted to fishponds more than 25 years ago. The carbon levels in these control sites will then be subtracted from the remaining carbon levels in the ponds being replanted to determine the **net residual carbon** (the carbon that would be locked into the sediment at the point of mangrove restoration). Production of the PDD should then enable the level of deferred carbon loss and the predicted accumulation of carbon in the sediment, AGB and BGB over the 25 years, to determine the number of carbon credits (both ex-post for the avoided carbon loss in the sediment and ex-ante for the predicted accumulation) that would be issued if the project was implemented. Completion of this stage will then determine the costs of the credits (known as the issue price).

Stage 3 – implementation. rePLANET is committed to financing the project in accordance with the agreed budget and payment schedule. In exchange YBBI will transfer the carbon credits to rePLANET at the agreed issue price. The payment schedule agreed between rePLANET and Yayasan Bunga Bakau Indonesia ensures a significant cushion between payment and when funds would be needed by YBBI, so that funds are always available in the accounts to meet the financial demands each year. rePLANET will fund the project through the sale of carbon credits, and the profits from these sales will be used to fund the start-up costs for additional Plan Vivo reforestation projects.

Around 450 farmers will directly benefit from the scheme and, with an average of 5 dependents, this gives 2250 people directly benefiting from these payments. This is based on the assumption that, on average, each farmer will contribute between 1 and 2 ha to the project (using 1.5ha here to calculate this). As most farmers have 3-4ha of empangs each, we think many will put in 1-2 ha to this project, and continue in their current ways with their remaining 1-2ha.

In addition, 35 communities will receive payments from reforestation of just 700ha of the total targeted area. Note more farmers than those required for the 700ha of this project may come forward and the area to be reforested could be increased.

One of the problems in funding this scheme is that a large percentage of the payments are in the first year when the land is purchased or leased and then planted before the audit is completed and carbon credits can be issued. To reduce the up-front investment, it is proposed to stagger the implementation with 350ha completed in year 1 with the credits issued for that area and then sold to fund a similar level of investment in year 2. Doing it this way makes it slightly more expensive (additional audit is needed and the credits are slightly more expensive to buy) but it makes the cashflow forecast for the project more attractive to funders as less funding is needed before the first batch of credits become available.

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## Appendix 1 – Proposed carbon accounting method to be used subject to approval at PDD stage by Plan Vivo

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**Dr Ian Hendy, University of Portsmouth**
**Professor Martin Speight, St Anne's College, University of Oxford**

### 1. Introduction

This report discusses the problems that arise when the carbon sequestration value of the sediment below mangroves is not fully accounted for. This concerns not only annual accumulation rates but also the net residual carbon at the time of planting. The sequestering value of replanting mangrove forests is therefore significantly underestimated.

The reason that this is important is that the price of voluntary carbon credits being used by multi-national companies to achieve Net Carbon Zero targets is primarily determined by the amount of carbon sequestered over the lifetime of the project being certified. Thus, for reforestation projects of rainforest areas with an estimated accumulation of 100 tonnes per hectare of carbon in above and below ground biomass combined (the carbon accumulation in rainforest soils is negligible) over a 25-year period then the price of the credits is generally in the region of $15. As a result, many reforestation projects are agro-forestry projects since the costs of the credits can be reduced to around $12 because of the income received from the coffee, cacao or other forest products which reduces the payments that need to be made to communities to continue to protect the forests. However, the net effect of these prices is that multi nationals faced with offsetting of millions of credits a year gravitate to renewable energy credits which can be bought for less than $5.

However, as identified in the Oxford Principles there needs to be a shift towards carbon removal, where offsets either directly protect existing carbon sequestration stores or remove carbon from the atmosphere as opposed to just reducing the amount of additional carbon being emitted (e.g. renewable energy or Tesla credits which can be sold for as little as 87 cents). These Principles should be moving multi nationals towards reforestation projects particularly those where large amounts of carbon are locked away in waterlogged and anoxic soil or sediment conditions such as peat and mangrove forests.

That this move towards reforesting mangroves using carbon credits has not yet occurred is to a large extent due to the costs of the credits being offered for reforestation projects compared with much cheaper renewable energy costs. The costs of credits in turn are related to how much carbon is being sequestered in any scheme and for mangroves it is argued in this report that it is being substantially underestimated by the current Clean Development Mechanism (CDM) accounting methods.

Section 2 reviews data on sequestration amounts of carbon in existing mangroves and compares it with predicted levels from the CDM methodologies (AR-AMS0003 and AR-AM0014). Section 3 looks at the literature for estimating above ground biomass (AGB), below ground biomass (BGB) and carbon accumulation in the sediment for 25 year restored mangroves in Indonesia and suggests conservative figures for the amount of carbon that could be accumulated form these 3 sources over 25 years. Section 4 examines data on the loss of sediment carbon once mangroves are removed, and section 5 describes how net residual carbon could be estimated at the time of planting. Section 6 describes the methods to be used for monitoring carbon accumulation over the 25 years of the project. Using this modified approach should give a much closer match between observed and predicted carbon storage in mangrove ecosystems.

## 2. Mangrove carbon storage

The total area of mangroves in the world has been estimated at around 130,420 km$^2$ (Tang et al 2018). Except for peatlands, mangroves store more carbon per unit area than any other ecosystem (Twilley et al., 2018; Along, 2020; Osland et al., 2020). In rainforests leaf falls are quickly recycled and the carbon released by oxidation. In mangroves the waterlogged soils in which they grow produce anoxic conditions that prevent the fallen leaves from decomposing thus oxidising their carbon – thus creating long term carbon stores. If we compare the carbon held in mangroves with that in terrestrial rainforests, Cameron et al (2021), using Fijian mangroves as an example, state that “mangrove carbon equates to 73.3%

of the carbon held by rainforests, despite occupying just 7.3% of the total area". Globally, the carbon stored by mangroves is equivalent to more than twice the annual global emissions of carbon dioxide by human (anthropogenic) activities (Elwin et al 2019), an astonishing observation. According to Alongi (2014) mangroves across the world have a mean whole-ecosystem carbon stock of 956 tonnes of carbon per hectare, whereas rainforests only have 241 tonnes of carbon per hectare.

Most of the carbon in mangrove soils is derived from either fallen leaf litter, dead timber, roots, or phytoplankton brought in on the tides (Adame et al 2018). Values vary according to publications but if carbon stocks in the soil as well as those in above and below ground plant tissues are summed together (to produce an estimate of total ecosystem carbon stocks – ECS) the values range from 9.4 billion tonnes to 13 billion tonnes (9.4 Pg C to 13 Pg C) globally (Tang et al 2018). Kauffman et al (2020) report that mangroves globally store about 11.7 billion tonnes (11.7 Pg) C - an aboveground carbon stock of 1.6 billion tonnes (1.6 Pg) carbon and a below ground carbon stock in the sediments and roots of 10.2 billion tonnes (10.2 Pg C).

There are many scientific papers that provide examples of published data describing whole ecosystem (above and below ground plus soil) mangrove carbon stocks on a per hectare basis, as summarised in Table 1. The overall average of these data in the table is around 800 tonnes per hectare, but with a lot of variation. Some figures are lower than others, likely in part at least to be linked to geography, higher latitudes, variable sample depths in the soil, estuarine versus oceanic locations, and so on.

**Table 1**. Whole ecosystem mangrove carbon stocks reported in the published literature (value ranges or means). Values displayed represent tonnes (Mg) per hectare.

| COUNTRY/REGION | CARBON STOCKS | AUTHOR | YEAR |
|---|---|---|---|
| Global | 300 to 1000 | Sidik et al | 2019 |
| Global | 965 | Alongi | 2014 |
| Global | 1023 | Donata et al | 2011 |
| China | 275 ± 104.6 | Yu et al | 2021 |
| China | 355 ± 82.2 | Liu et al | 2014 |
| Indonesia | 950.5 | Alongi et al | 2016 |
| Indonesia | 1083 ± 378 | Murdiyarso et al | 2015 |
| Peninsular Malaysia | 427.9 to 512.5 | Rozainah et al | 2018 |
| Singapore | 307.4 | Friess et al | 2016 |
| S.E. Asia | 950 | Thorhaug et al | 2020 |
| Thailand | 1029.5 ± 100.7 | Elwin et al | 2019 |
| Vietnam | 889 ±111 | Nam et al | 2016 |
| Vietnam | 765 to 1026 | Dung et al | 2016 |

Indonesia has the largest extent of mangroves of any country in the world, estimated to cover around 2,707,572 hectares or just over 27,000 km2 (Thorhaug et al 2020). The rough average figure for mangrove carbon stocks in Indonesia from the table is approaching 1000 tonnes per hectare. Murdiyarso et al (2015) points out that the above-ground carbon storage of natural mangrove forests in Indonesia was an average of 211±135 tonnes per hectare, and 849±323 tonnes per hectare in the sediment, giving estimates for overall ecosystem carbon stocks of 1083±378 tonnes per hectare, so approximately 78% of total ecosystem stocks are in the soil.

Jakovac (2020) estimated that restoring the 1540 km² mangroves lost just over the 17 years from 2000 would sequester 123 billion tonnes of carbon dioxide. Given this statistic then restoration of mangroves should surely be one of the prime targets for any reforestation initiative.

How do predicted levels of carbon using the CDM carbon methodology compare with these figures from the literature? Adame et al (2018) measuring carbon in replanted mangroves in peninsula Malaysia recorded 1169 ± 69.8 tonnes per hectare in the sediment, just 15 years after restoration, yet this should have taken

2000 years to reach this figure using the CDM methodology. Likewise Dung et al (2016) found mean sediment carbon storage of 910 ± 32.3 tonnes of carbon per hectare in 38-year-old restored mangrove forests but this should have taken 1800 years to reach these levels if the CDM methodology was used. There are two possible reasons for this discrepancy – either the amounts of carbon accumulating each year in newly planted mangroves has been significantly underestimated, or the levels of carbon at planting were not measured. This report argues that both are significant factors in the underestimation of observed levels of carbon in restored mangrove areas.

## 3. Predicting carbon accumulation in 25-year-old restored mangroves in Indonesia

Above Ground Biomass (AGB) can be estimated by satellite imagery (e.g. LANDSAT), LIDAR, and drone photography etc (Nguyen et al 2019, Wong et al 2020, Lucas et al 2021). AGB figures are highly tree or shrub species specific as shown by table 2. For example, work in southern Sulawesi (Indonesia) showed that the above ground biomass of *Rhizophera apiculata* in a protected area was 651.6 tonnes per hectare whereas that of *R*. *mucronata* also in the same protected area was only 232.1 tonnes per hectare (Kanguso et al 2018). The carbon content of AGB figures is around 50% so the carbon content will be roughly half those figures, but it is unknown how long the forests took to establish these carbon levels with the exception of Lucas et al (2019) who showed that mangroves had an above ground biomass of ~50 tonnes per hectare at 5 years after clearance which grew to more than 200 tonnes per hectare by ~30 years post-clearance.

**Table 2**. Published estimates of above ground biomass (AGB) in South and Southeast Asia. Values displayed represent tonnes (Mg) per hectare.

| COUNTRY/REGION | ABOVE GROUND BIOMASS | TREE GENERA/SPECIES | AUTHOR | YEAR |
|---|---|---|---|---|
| India (Sundarbans) | 40.4 | *Avicennia, Sonneratia, Bruguiera, Rhizophera spp* | Barik et al | 2021 |
| Indonesia | 159.1 | Various | Alongi et al | 2016 |
| Indonesia (Kalimantan) | 118 ± 8 | *Avicennia alba, Bruguiera sexangula, Rhizophera apiculata* | Arifanti et al | 2019 |
| Indonesia (Sulawesi) | 154.6 to 651.6 | *Ceriops tagal, Rhizophera apiculata, Rhizophera mucronata* | Kangkuso et al | 2018 |
| Malaysian Borneo | 135.6 to 291.3 | *Avicennia alba, Rhizophera apiculata* | Wong et al | 2020 |
| Peninsular Malaysia | ~50 to ~ 200 | *Rhizophera apiculata, Rhizophera mucronata* | Lucas et al | 2021 |
| Vietnam | 102 to 298 | *Avicennia alba, Rhizophera apiculata* | Dung et al | 2016 |
| Vietnam | 59.1 to 78.6 | Many | Nguyen et al | 2019 |

There are allometric equations to link diameter at breast height (dbh) measurements to AGB for most species of mangrove in Kauffman & Donato (2012). However, these equations are not tied to growth rates over time, so using data from re-established mangrove areas for AGB of known ages is likely to give a more accurate estimate of likely AGB carbon levels at certain time intervals. Dung et al (2016) found AGB levels of 214.5 ± 32.5 tonnes of carbon per hectare in the Mekong Delta 38 years after having been destroyed by Agent Orange. Adame et al (2018) examining an area of mangroves in peninsula Malaysia that are harvested on a 30-year rotation were able to quantify AGB carbon accumulation over time and compare it the figures with long term protected forests. They noted that after 25 years the reforested mangroves which had been subjected to light thinning at 15 years and 20 years, had a AGB carbon level of 125 tonnes per hectare.

Below ground biomass - BGB (and therefore below ground carbon storage) is composed of living and dead mangrove roots, and there is usually a good correlation between AGB and BGB (Barik et al 2021), with the latter showing lower values than the former. The ratios between AGB and BGB tend to be species specific, since different mangroves have different root structures, such as the prop roots of *Rhizophora* species the majority of which is above ground, and the “pencil” roots of *Avicennia* species where main lateral roots are in the soil sending up the aerial pneumatophores at regular intervals. So for example, *Rhizophora apiculata* was found to have an average AGB to BGB ratio of around 2.7:1 in Sulawesi, Indonesia (Chen et al 2018) and 2.2:1 in Peninsular Malaysia (Rozainah et al 2018a). It is to be expected that as the trees grow and the stem and foliage structures increase in volume, the AGB to BGB ratios increase in favour of above ground. In southern China it was found that 15 year old Avicennia marina had an AGB to BGB ratio of only ~1.4 whilst 45 year old trees of the same species in the same site had a ration of ~2.5 (Yu et al 2021). An average of 2.5:1 for a mixed plantation of *Rhizophora* and *Avicennia* should therefore give a conservative estimate of BGB carbon stocks – 50 tonnes per ha after 25 years based on the AGB carbon figure quoted above.

**Table 3**. Published accumulation and sequestration for carbon in mangroves. Values displayed represent tonnes (Mg) per hectare.

| COUNTRY/REGION | MAJOR TREE SPECIES | ACCUMULATION RATES | AUTHOR | YEAR |
|---|---|---|---|---|
| Global | Not specified | 1.74 | Alongi | 2012 |
| Global | Not specified | 2.3 ± 2.8 | Jennerjahn | 2020 |
| Global | Not specified | 1.5 to 2.0 | Lovelock et al | 2017 |
| Australia | *Avicennia marina* | 2.2 to 4.3 | Lamont et al | 2020 |
| India | *Avicennia marina, Rhizophora mucronata* | 2.75 to 4.80 | Kathiresan et al | 2013 |
| Peninsular Malaysia | *Rhizophora apiculata* | 2.8 to 9.5 | Adame et al | 2018 |
| S.E. China | *Kandelia obovata, Sonneratia apetala* | 1.55 | Lunstrum and Chen | 2014 |
| S.E. China | *Avicennia marina, Rhizophora stylosa* | 2.8 to 3.6 | Yu et al | 2021 |

Again, very variable data, but based on a literature review, Lunstrum and Chen (2014) concluded that "rates of soil carbon accumulation were correlated to a number of factors, notably climate, soil texture, land-use prior to afforestation, and (tree) species". One of the studies in table 3 is the work of Adame et al (2018) in Peninsular Malaysia who examined an area of mangroves that were being harvested on a 30-year rotation so there were stands of mangroves of known ages and areas where the residual carbon in cleared areas had been calculated. This study suggested that reforested plots recovered soil carbon rapidly in the first 10 years post-restoration, with carbon accumulated at a rate of around 9.5 tonnes per hectare per year. However, after 10 years, accumulation rates declined to about 2.8 tonnes per hectare per year (Adame et al 2018). In S.E. China, Yu et al (2021) measured ecosystem carbon stock accumulation of 3.61, 3,43 and 2.78 tonnes per hectare per year for 15, 45 and 80-year-old mangroves respectively. Young forests in the early years of restoration accumulate soil carbon most rapidly and sequestration rates of carbon in mangroves depends on species (Kathiresan et al 2013). It is clear from table 3 that the most productive species in terms of carbon accumulation are in the mangrove genera *Avicennia* and *Rhizophora* and that over a 25-year period an accumulation rate of at least 3.5 tonnes per ha per year would be a conservative estimate. Figures as high as 7.32 tC/ha/yr have been approved for a Verra certified scheme in Myanmar.

Given the above review a mixed plantation of *Rhizophera* and *Avicennia* species in Indonesia could reasonably be expected to be certified for a total carbon accumulation over 25 years of 250+ tonnes or even higher if Verra approved accumulation rates were achieved. This would form the basis for an ex-ante credit application.

## 4. Residual carbon after mangrove deforestation or conversion

Richards et al (2020) estimate that the global mangrove carbon stock declined by around 15.8 million tonnes (158 Mt) between 1996 and 2016. 62% of mangrove losses around the world between 2000 and 2016 were due to conversion to aquaculture and agriculture, mainly in SE Asia (nearly 80% of these losses) where commodities including rice, oil palm and shrimp farming were dominant (Goldberg et al 2020). In SE Asia, over 114,000 hectares of mangrove have been converted to aquaculture ponds, rice or oil palm between 2000 and 2012 (Sharma et al 2020).

Mangrove conversion to other types of land use, releases massive quantities of carbon dioxide (and other greenhouse gases including methane and nitrous oxide) to the atmosphere from the carbon stocks in the sediments. Table 3 presents carbon emission data resulting from mangrove conversion from the literature. These data are very variable, but if for now we ignore the extremely low and high estimates (Atwood et al and Alongi et al) a very rough approximation suggests mangrove deforestation and conversions could result in carbon emissions of around 70 million tonnes of carbon per year. Despite these very variable figures, Indonesia had the highest potential of all countries for such losses (Atwood et al 2017). Additionally, it is likely that such emissions will continue for many years post-conversion, as soil carbon stocks In the ex-mangrove sites are broken down and carbon dioxide (plus other GHGs) are released into the atmosphere over years if not decades (Sharma et al 2020). Sippo et al (2020) suggest that even if no more mangrove deforestation occurs, continuing carbon losses to the atmosphere and the ocean from the sediment might reach 27 million tonnes of carbon globally over the next 30 years.

**Table 4**. Estimated global greenhouse gas emissions resulting from mangrove conversion reported scientific literature. Published data in carbon dioxide equivalents converted to tonnes of carbon per year.

| CARBON EMISSIONS | AUTHOR | YEAR |
|---|---|---|
| 20 million to 120 million | Donato et al | 2011 |
| 65 million | Pendleton et al | 2012 |
| 133 million | Alongi and Mukhopadhyay | 2015 |
| 90 million to 970 million | Alongi et al | 2016 |
| 1.9 million | Atwood et al | 2017 |
| 21 million to 86 million | Hamilton and Friess | 2018 |
| 13.7 million | Sippo et al | 2020 |

When mangrove forests are converted into oil palm plantations or shrimp farms, not all the soil carbon is lost. Much of the scientific literature concentrates on the carbon stocks remaining in abandoned aquaculture ponds. This carbon must be derived from stocks accumulated when the mangroves were intact – shrimp ponds do not accumulate much, if any, on their own. For example, mangroves in Eastern Kalimantan (Indonesia Borneo) were reported to hold mean total ecosystem carbon stocks of 1023±87 tonnes of carbon per hectare, compared with 499±56 tonnes carbon per hectare in adjacent abandoned shrimp ponds (Arifanti et al 2019). Research in Thailand reported that 50% of soil organic carbon and up to 90 % of total ecosystem carbon were lost when mangroves were converted to shrimp farms (Elwin et al 2019). The authors of this paper suggest that most carbon stocks that remain after mangroves are converted to shrimp farms are in the deepest soils, perhaps 2.5 metres deep or more where present.

There are few published estimates of this residual carbon stock after simple cutting of mangroves for firewood or building materials. Adame et al (2018) estimated that recently clear-cut mangrove soils had 29% less organic carbon than intact mangroves. These cleared areas in the Adame et al (2018) study were then immediately replanted so the figures relate just to the immediate losses on clearance of mangrove forest. In New Zealand, Perez et al (2017) found that mangroves deforested 10 – 12 years previously contained residual stocks of organic carbon 40% lower than the preserved (natural) mangrove forests.

One other way of assessing carbon stocks after deforestation but in the absence of any conversion to a different land use type is to use natural, climate related, dieback events or cyclone damage as ways of removing healthy mangroves. Some dead trees will remain above ground for a little while post-dieback, but in the main, the only substantial total ecosystem carbon stocks will be those below ground. A piece of research carried out in tropical Australia found that sediment (soil) carbon stocks were 183±12 tonnes per hectare in the dead forest (Sippo et al 2020). This carbon can be considered to be the residual stock remaining after the living trees had been removed. A large literature review concluded that 54%±13% of mangrove soil carbon stocks were lost when intact forest underwent one form of land use change or another (Sasmito et aL 2019) and we must assume that some of the remaining ~46% of soil carbon would gradually be released carbon back to the atmosphere via oxidation for years post-conversion.

It is clear that whilst loss of mangrove cover results in a loss of a percentage of the sediment carbon, the rate of that loss and how long the losses continue is likely to be determined by factors such as position and the land use to which the area is converted. In areas exposed to strong water currents and large tidal ranges on the seaward edge of mangroves, or on the river edge of mangrove stands, sediment stores could be scoured out to much deeper areas once the mangrove cover protecting that loss is removed. However, in other more sheltered areas (landward edge of mangrove stands) the loss of carbon would not be complete and in the absence of active management of the area (e.g. farming, aquaculture) or removal of harvesting pressure (for fuel or timber), the mangroves would return as the dominant vegetation.

The proposal for a new methodology therefore includes the concept of net residual carbon in the sediment at the point of planting. Since this will vary enormously between sites, the intention would be for control areas which were cleared of mangroves over 25 years ago to be identified for each area that is due to be planted. Global Mangrove Watch provides worldwide data on the distribution of mangroves in 1998, 2007 and 2016 and these data are the basis of many research papers about the change of mangrove cover worldwide. However, examination of Google Earth satellite data from 1985 onwards reveals the presence of mangroves in many areas that are were lost even by the time of the first Mangrove Watch data set in 1996. The dates when these areas lost their mangrove cover can be verified with elders in local villages. Determining their residual carbon after a long period where the mangroves have been removed would provide a baseline figure of the levels to which carbon would fall if the areas to be replanted were not reforested. Note each of the areas to be replanted would need to be matched to control areas that have the same level of exposure to currents and tidal range as the areas to be planted. Soil cores would also be needed for the areas to be replanted to account for the residual carbon still remaining at the time of planting (this would vary by how long the areas had been exposed by removal of the mangroves). **Net Residual Carbon** in the sediment for each block of planting would be the measured carbon at the time of planting minus the residual carbon in counterpart control areas of long deforested mangrove areas. Net Residual Carbon would form the basis of an ex-post credit application immediately after planting was completed and the carbon stores locked in. This would be a separate (albeit linked) application to the application for ex-ante credits (see section 3). Taken together though the predicted levels of ecosystem carbon in 25 year old restored mangrove stands in Indonesia should more closely match the observed levels in the literature.

## 5. Suggested method for estimating net residual carbon in planting areas

It is proposed that for Plan Vivo carbon credit applications that immediately prior to planting, the residual storage of carbon in the sediment of the areas to be planted should be measured from coring to a 2m depth. Multiple transects covering a cross section of the areas to be planted, running perpendicularly from the shoreline should be installed. Each transect should run from the fringe mangroves adjacent to the shoreline, through the interior mangroves to the sea/river outer edge. Six sample points at equal distances along the transect should be positioned to cover the proposed planting area. At each sample point, the first step is to measure the depth of the sediment to the bedrock or coral sand using a steel pole at each of the sample points. Once this is completed three core samples should be completed using an augur: one on the transect and two at 10m either side of the transect. After removal of the litter layer, from each core 5 samples of 5cm deep discs should be cut from the midpoint of depths 0 – 15cm, 15-30cm, 30 – 50cm, 50 – 100cm and 100- 200cm, or to the maximum penetration of the corer if less than 200cm. These discs should be wrapped in aluminium foil and sealed in polyethylene bags to avoid gas exchange. All sample discs should be labelled and stored in a cooler before being transported to a freezer.

This sampling routine for the proposed planting area should be replicated in control areas which have been cleared of mangroves up to 25 years previously. Care must be taken to replicate the positioning of control areas in terms of exposure to currents, waves, tides, estuaries etc to those of the proposed planting areas. The estimated carbon tonnage in these control areas will be subtracted from the estimated carbon tonnage figure in the counterpart areas to be planted to determine Net Residual Carbon levels which will form the basis for the ex-post credit application.

The 5cm sediment disc samples would be supplied to the laboratories frozen. The analysis methods are described in Sollins et al (1999) and the method described below is taken substantially from that paper. In order to calculate bulk density each sample needs to be dried at 60 degree Celsius for 48 hours. Note that drying at higher temperatures to boil away water should not be carried out because this affects the carbon values and the same samples cannot then be used for carbon determination. Bulk density is then determined by dividing the oven-dry soil sample weight in g by the volume of the sample. The volume of each sample will be determined by V=πr2h where r is the radius of the corer and h is the height of the disc (in this case 5cm). The bulk density value is then given in grams per cubic cm.

*C and N Analysis by Dry Combustion*

Most dry-combustion C and N (CN) analyzers oxidize samples at high temperature (approx. 1000 °C), then measure the $CO_2$ and N gases evolved by infrared gas absorption (IRGA) analysis or gas chromatography (GC). Depending on the individual instrument, the maximum allowable sample size may be as small as 2 µg – 30 µg . This means each 5cm disc dried sample needs to be ground up and 3 subsamples put into the tin tray line which means that each core will need 15 samples in the line, so only 2 complete cores can be done in each run (see below). The maximum sample size depends on the C concentration, which may require some initial data before a strategy can be chosen. No hard-and-fast rules can be offered for sample size because the precision and accuracy needed for any individual sample depend on the overall sampling and data analysis scheme. Use of small samples, however, always requires careful attention to subsampling and especially to grinding.

High-temperature multiple-sample dry-combustion analyzers are manufactured by several companies including LECO and Carlo-Erba. The Carlo-Erba NA 1500 elemental analyzer is discussed here. The detection limit is 10 ppm, and measurements are reproducible to better than ±0.1% absolute value. Sample mass needed for analysis may range from 0.5 to 30 µg depending on the nature of the material. Because such a small sample is needed, material must be homogenized thoroughly by grinding several hundred grams of soil to pass a 40- to 60-mesh screen. A typical sample run comprises one or two "bypass" samples of high concentration to condition the columns, two "blanks" consisting of empty tin sample cups, three standards of known C and N composition to calibrate the instrument (EDTA is used commonly), and three to five check standards scattered throughout the sample run. Typically, 39 unknowns can be included in one run of 50 samples. Extra sample trays may be purchased and set up to make consecutive runs more convenient. Samples are weighed into tin capsules, which are loaded into an autosampler that drops the capsule plus sample into a combustion column maintained at 1020 °C. The sample and container are flash combusted in a temporarily enriched atmosphere of oxygen. The combustion products are carried by a carrier gas (helium) past an oxidation catalyst of chromium trioxide kept at 1020 °C inside the combustion column. To ensure complete oxidation, a layer of silver-coated cobalt oxidè is placed at the bottom of the column. This catalyst also retains interfering substances produced during the combustion of halogenated compounds. The combustion products (CO2, CO, N, NO, and water) pass through a reduction reactor in which hot metallic copper (650 °C) removes excess 02 and reduces N oxides to N2 . These gases, together with CO2 and water, are next passed through magnesium perchlorate to remove water, then through a chromatographic column to a thermal conductivity detector. The detector generates an electrical signal proportional to the concentration of N or C present. This signal is graphed on a built-in recorder and ported to a computer, which integrates the area under each curve and converts it to concentrations after each sample is run. Before the start of each run, pressure should be checked to ensure against gas leaks. Gas flow rates (helium, oxygen, and air) are checked with a stopwatch and set to the correct values. Routine maintenance involves removing the slag (residue from combustion of the tin sample capsules) from the top of the combustion column after 150 samples, then refreshing the top 10 cm of the column with Cr0 3. The combustion column and its chemicals can be used for 350-425 samples. The reduction column can be used for up to 900 samples, or until its copper is three-fourths spent as indicated by change to a black colour. The moisture trap must be changed every 300-350 samples.

Most CN analysers read out directly in concentration units. %C is the carbon concentration expressed as a whole number. The soil carbon mass per sampled depth interval is calculated as follows:

Soil carbon in tonnes per ha = bulk density (g per cubic meter) X soil depth interval in cm X %C.

**6. Suggested method for monitoring the planted mangroves**

Monitoring of new mangrove plantations to measure carbon accumulation and biodiversity benefits is essential (Matsui et al 2012). Survival of the transplant and resultant young trees must be followed, and the progress of carbon accumulation in absolute terms and relative to predicted levels monitored. These data would be used for the 5-year audits to confirm this progress. At the moment, there are rather few mangrove restoration projects that are more than 20 or so years old (Sasmito et al 2019), and as these authors point out, “there is clear need for systematic long-term monitoring and evaluation of reforestation performance”.

Carbon levels in the sediment would be measured in the planted areas using the methods described in Section 5 every 10 years. Annually the above ground biomass would be measured by the Operation Wallacea international teams of scientists with accompanying students, either using the methods described in Kauffman & Donato (2012), or alternatively employing various types of remote sensing technologies (Friess et al 2016). Above ground biomass can be calculated fairly accurately using remote sensed information such as tree or canopy height fed into tree species specific allometric equations available in the published literature for specific countries or regions, and individual mangrove tree species. However, the most accurate method is the measurement of diameter at breast height and identification of species and given the annual manpower available to the Opwall teams this can be achieved at no cost to the project.

Below ground biomass (BGB) can be estimated from the AGB figures using more equations which have been developed to relate various aerial parameters including diameter at breast height (dbh) wood density, frond length etc to root biomass (Elwin et al 2019), again underlining the importance of having ground surveys annually. Remote sensing is being employed more and more frequently these days to estimate AGB in mangroves, and indeed it is now a requisite for the monitoring, reporting and verification (MRV) system of the UN REDD programme (Nesha et al 2020). Satellite imagery of various types, LANDSAT for example (Lucas et al 2020a), can provide data from which canopy height amongst other things can be estimated (Lucas et al 2020b), assuming the availability of appropriate software, personnel to operate it, and funding to pay for these procedures. Unmanned aerial vehicles (UAVs – drones) are now being recommended as viable alternatives to more expensive and cloud cover dependent satellite remote sensing (Navarro et al 2020).

Annual data on the aquatic macro-invertebrate, fish, reptile, bird and mammal usage of the recovering mangroves will be collected free of charge for all rePLANET funded schemes.

Data on annual carbon sequestration, aquatic invertebrates, fish, reptile, birds and mammals together with pictures of each hectare of land and the recovering mangroves taken each 6 months by the farmers from agreed set photographic locations and linked to release of the 6-monthly payments, ownership details and beneficiaries of the annual payments, will be included on the Oxford University Long-term Ecology Lab website for all projects funded by rePLANET.

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## Appendix 2 – Supporting letter from Indonesia's Forest Area Designation Bureau (BPKH)

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
DIREKTORAT JENDERAL PLANOLOGI KEHUTANAN DAN TATA LINGKUNGAN
**BALAI PEMANTAPAN KAWASAN HUTAN WILAYAH XXII**
Jalan Balai Kota III Nomor 42 Kota Kendari Provinsi Sulawesi Tenggara
Telp/Fax. 0401- 3417246 ; Email: bpkh22kendari@gmail.com

| | | | |
|---|---|---|---|
| Nomor | : | S.396 /BPKH XXII/ISDHL/PLA.1.3/7/2021 | 19 Juli 2021 |
| Sifat | : | Penting | |
| Lampiran | : | 3 (tiga) lembar peta | |
| Hal | : | Surat Konfirmasi | |

Yth. Pendiri Yayasan Bunga Bakau Indonesia
di
Baubau

Memperhatikan maksud Surat Saudara tanggal 23 Juni 2021 Perihal Permohonan Surat Konfirmasi, bersama ini dengan hormat disampaikan beberapa hal sebagai berikut :

1. Konfirmasi kawasan hutan dilakukan terhadap data *shapefile* yang disampaikan kepada kami, serta mengacu dan memperhatikan pola ruang kehutanan sebagaimana tertera pada :
   a. Peta Perubahan Peruntukan Kawasan Hutan menjadi Bukan Kawasan Hutan seluas ± 110.105 (seratus sepuluh ribu seratus lima) hektar dan Perubahan Antar Fungsi Kawasan Hutan seluas ± 115.111 (seratus lima belas ribu seratus sebelas) hektar di Provinsi Sulawesi Tenggara Skala 1 : 250.000 (Lampiran Keputusan Menteri Kehutanan Nomor SK.465/Menhut-II/2011 tanggal 9 Agustus 2011);
   b. Peta Perkembangan Pengukuhan Kawasan Hutan Provinsi Sulawesi Tenggara Sampai Dengan Tahun 2018 Skala 1 : 250.000 (Lampiran Keputusan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor SK.9422/MENLHK-PKTL/KUH/PLA.2/11/2019 tanggal 6 November 2019);
2. Konfirmasi kawasan hutan adalah sebagai berikut :
   2.1. Fungsi Kawasan Hutan
   Fungsi kawasan hutan pada areal yang dikonfirmasi :
      2.1.1. Kabupaten Bombana seluas lebih kurang 31,08 Ha (data luas berdasarkan *shapefile*) terletak pada kawasan Hutan Lindung (HL) Kompleks Hutan Gunung Mendoke dan pada kawasan Hutan Produksi Konversi (HPK) Kompleks Hutan Gunung Tompobatu seluas lebih kurang 0,39 Ha.
      2.1.2. Kabupaten Muna seluas lebih kurang 32,46 Ha (data luas berdasarkan *shapefile*) terletak pada kawasan Hutan Lindung (HL) Komplek Hutan Katangana seluas lebih kurang 0,27 Ha, Kompleks Hutan Kaudani seluas lebih kurang 6,93 Ha, Kompleks

Hutan Labalano lebih kurang seluas 16,59 Ha, Kompleks Hutan Langko-Langko lebih kurang seluas 1,97 Ha, Kompleks Hutan Malambo seluas lebih kurang 5,28 Ha dan Kompleks Hutan S.Tiworo seluas lebih kurang 1,42 Ha.

2.1.3. Kabupaten Konawe Selatan seluas lebih kurang 3,42 Ha (data luas berdasarkan *shapefile*) terletak pada kawasan Hutan Lindung (HL) Kompleks Hutan Torobulu seluas lebih kurang 3,02 Ha dan Kompleks Hutan Papalia seluas lebih kurang 0,4 Ha serta terletak pada Hutan Suaka Alam (HSA) seluas lebih kurang 0,39 Ha.

2.2. Status Kawasan Hutan

Status kawasan Hutan telah ditata batas.

3. Konfirmasi kawasan hutan sebagaimana disebutkan pada bagian sebelumnya dilakukan di atas peta dan digambarkan sebagaimana peta terlampir yang merupakan satu kesatuan dengan konfirmasi kawasan hutan ini. Dalam hal terdapat keraguan terhadap posisi dan letak lokasi yang dikonfirmasi, dapat berkoordinasi dengan kami maupun pengelola kawasan hutan yakni Dinas Kehutanan Provinsi Sulawesi Tenggara. Sepanjang tidak dilakukan perubahan terhadap data *shapefile* yang di sampaikan kepada kami, konfirmasi kawasan hutan ini tetap berlaku dan apabila terdapat kekeliruan terhadap materi konfirmasi ini, akan dilakukan perubahan dan perbaikan sebagaimana mestinya menurut peraturan perundangan yang berlaku.

Demikian, atas perhatian Saudara diucapkan terimakasih.

Kepala Balai

Dr. Pernando Sinabutar, S.Hut., M.Si
NIP. 19720131 199903 1 002

Tembusan :

1. Sekretaris Direktorat Jenderal Planologi Kehutanan dan Tata Lingkungan (sebagai laporan).
2. Direktur Rencana, Penggunaan dan Pembentukan Wilayah Pengelolaan Hutan.
3. Direktur Pengukuhan dan Penatagunaan Kawasan Hutan
4. Kepala Dinas Kehutanan Provinsi Sulawesi Tenggara.

MINISTRY OF ENVIRONMENT AND FORESTRY

DIRECTORATE GENERAL OF FORESTRY AND ENVIRONMENTAL PLANNING
**FOREST AREA DESIGNATION BUREAU AREA XXII**
Jalan Balai Kota III Nomor 42, Kendari City, Southeast Sulawesi Province
Tel/Fax: 0401- 3417246 ; Email: bpkh22kendari@gmail.com

Number : S.396/BPKH XXII/ISDHL/PLA.1.3/7/2021 19 July 2021
Nature : Important
Attachment : 3 (three) Map pages
Regarding : Confirmation Letter

Dear Founder of Yayasan Bunga Bakau Indonesia
In
Baubau

We note the meaning of your letter dated 23rd June 2021 regarding Request for Confirmation Letter, and we hereby respectfully deliver a few points as follows:

1. A comparison of forestry designated areas in relation to the data shapefile that we received from you, was carried out and we referred to the listed forestry spatial areas as outlined on the following maps :
    1. Updated Forest Boundary Map, whereby +/- 110,105 (one hundred and ten thousand, one hundred and five) hectares of originally allocated forestry changed status to become non-forestry areas, and whereby +/- 115,111 (one hundred and fifteen thousand, one hundred and eleven) hectares of allocated forestry areas changed zonation type in Southeast Sulawesi, scale 1:250,000 (attached decree from Ministry of Forestry, number SK.465/Menhut-II/2011 dated 9 August 2011);
    2. Progress Map Consolidating Forestry Areas in Southeast Sulawesi, up until year 2018 scale 1:250,000 (attached decree from MoEF number SK.9422/MENLHK-PKTL/KUH/PLA.2/11/2019 dated 6 November 2019);

2. Confirmation of Forestry Areas are as follows :
    1. Functioning Forestry areas overlapping your project data shapefiles are as follows :
        i. In **Bombana Regency there is an overlap area of +/- 31.08 ha** (as per your project data shapefile) that is located in the Protected forestry area of *Gunung Mendoke Protected Forest* and in the *Hutan Gunung Tombpobatu Converted Production Forestry Area* there is an overlap of +/- **0.39 ha.**
        ii. In **Muna Regency there is an overlap area of +/- 32.46 ha** (as per your project data shapefile) that is located within Protected Forestry areas as follows: +/- 0.27 ha falls within the *Katangana Protected Forest* area, +/- 6.93 ha falls within the *Kaudani Protected Forest*, +/-16.59 ha is within *Labalano Protected Forest*, +/- 1.97 ha is within *Langko-Langko Protected Forest,* +/- 5.28 ha is within the *Malambo Protected Forest*, and +/- 1.42 ha is within the *S. Tiworo Protected Forest*.
        iii. In **Konawe Selatan Regency there is an overlap of +/- 3.42 ha** (as per your project data shapefile) that is located in the Protected Forestry Areas of; *Torobulu Protected Forest Area* +/- 3.02 ha, and *Papalia Protected Forest*

*Area* +/- 0.4 ha. Additionally there is an overlap of **+/- 0.39 ha** located within a Wildlife Reserve Area.

2. Status of Designated Forestry Areas
    i. Designated Forestry Area boundaries are fixed.

3. Confirmation of Forestry Area overlaps as aforementioned in this letter, were carried out with the use of official maps and have been outlined in the attached maps, which form the basis of our response. Should there be any concerns regarding the designated forestry areas, you may coordinate further with us at the Department of Forestry for Southeast Sulawesi. In so far as no changes are made to the project data shapefiles as received by us, we confirm that the forestry area overlaps as mentioned here are valid. If a mistake has been made in this confirmation letter, changes and corrections can be made at a later date in accordance with the relevant regulations.

For your attention, we thank you.

Head of Section

Dr. Pemando Sinabutar, S.Hut, M.Si
NIP.19720131 199903 1 002

Copied to:
1. Secretary, Directorate General or Forestry and Planning (as a report)
2. Director of Planning, Use and Establishment of Forest Management Areas
3. Director of Consolidating Forestry Area Land Use
4. Head of Forestry Department, Southeast Sulawesi

## Appendix 3 – Supporting letter from Yayasan Bunga Bakau Indonesia

31 May 2021

**To Whom it may concern**

**Subject: Letter of Compliance**

This is a letter to state that our organization, Yayasan Bunga Bakau Indonesia, intends to conduct all activities in a legal and accountable manner. We hereby commit to comply with all International Laws and Indonesian National Laws.

Yours Faithfully,

**Muslimin Koimuddin**
**Chair Person**


**YAYASAN BUNGA BAKAU INDONESIA**

Jln. Bukit Permai,
Bukit Wolio Indah, Baubau,
Southeast Sulawesi, 93716

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