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Mangrove Planting Guidelines for Kiribati

SPREP
Secretariat of the Pacific Regional Environment Programme

For: Secretariat of the Pacific Regional Environment Programme (SPREP)

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Perth, March 2020

New Zealand – Pacific Partnership on Ocean Acidification:

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1. BACKGROUND

The New Zealand - Pacific Partnership on Ocean Acidification (NZPPOA) Project is a collaborative effort between the Secretariat of the Pacific Regional Environment Programme (SPREP), the University of the South Pacific, and the Pacific Community to build resilience to ocean acidification (OA) in Pacific island communities and ecosystems with financial support from the New Zealand Ministry of Foreign Affairs and Trade and the government of the Principality of Monaco. Kiribati is one of three pilot sites under the NZPPOA project.

The NZPPOA Project has three main focal areas; [1] research and monitoring, [2] capacity building and awareness raising, and [3] practical adaptations. Mangrove planting is one of the practical adaptation actions selected for implementation at Nanikai village (in South Tarawa), the NZPPOA project's pilot site in Kiribati.

The present report presents guidelines for mangrove planting in Kiribati. Although the focus of this report is on Kiribati, much of its contents can also be applied elsewhere in the Pacific region. These guidelines are based on a combination of a thorough literature review of mangrove planting efforts worldwide, evaluation of previous achievements in mangrove planting on Tarawa (Kiribati) and hands-on personal experience by the author in mangrove restoration projects at various locations worldwide.

The objectives of these guidelines is to offer practical guidance and technical support to any future mangrove planting efforts and initiatives in Kiribati and the wider South Pacific region.

These guidelines have been written for local government staff (e.g. from the Ministry of Fisheries or Environment), scientists and NGO's in the region, with the intention that they work in close collaboration with local communities to implement mangrove planting when and where that would considered appropriate.

Figure 1. Natural mangrove stand in North Tarawa

2. MANGROVES IN KIRIBATI

Distribution and species

Mangroves are found in low shrubby communities on several atolls in the Gilbert Islands of Kiribati, including Tarawa, Butaritari, Aranuka and Abemama. Baba et al. (2009) reported a total of 258 ha of mangroves on four atolls in Kiribati.

The mangroves in South Tarawa are dominated by *Rhizophora stylosa*, with some *Bruguiera gymnorhiza, Lumnitzera racemosa* and *Sonneratia alba* (Scott, 1993). The mangroves in South Tarawa have been affected by a growing human population, including clearance for development and pollution (Spalding et al., 2010). The acute shortage of land has led to extensive reclamation of the lagoon foreshore and loss of mangroves, along with their exploitation for construction material (Scott, 1993; p. 205).

Figure 2. *Rhizophora stylosa*

Appreciation of values of mangroves and previous planting efforts in Tarawa

The value of mangroves in preventing coastal erosion is widely accepted and understood, especially in view of the fragile physical nature of the atoll island in the face of sea level rise and other climate change-related threats (Rouatu, 2015).

There are growing efforts to restore and plant mangroves in Kiribati, including a project by the International Society for Mangrove Ecosystems, in association with local youth clubs and the government (MELAD), that has been planting mangroves in South Tarawa since 2005 as a means of reducing coastal erosion (Spalding et al., 2010; p.173; Baba et al., 2009; Baba, 2011).

Figure 3. *Rhizophora stylosa* mangroves planted along the Ananau causeway (Tarawa)

Mangroves have been planted to establish coastal green belts especially along the banks of the causeways using simple planting techniques, where possible involving local school children and youth (Baba et al., 2009). Particular successes have been achieved in areas along the Ananau Causeway near the airport (Figure 3), where 'close group' planted mangroves (see Baba, 2011) had high rates of survival (50-90%) and growth and now form an attractive environmental asset with significant coastal protection value. Further annual planting in this area has been undertaken as part of the Kiribati Adaptation Program- Phase III (KAPIII).

Mangrove planting efforts at other sites in South Tarawa have had much less success,

such as attempts in 2009 at Bonriki and Nanikai, where thousands of mangrove propagules were planted but with almost 100% mortality after 1.5 years, which was attributed to low soil nutrients, lack of freshwater, barnacle infestation, seaweed entanglement and poor drainage (Baba et al., 2009).

Rationale for mangrove planting in Tarawa

In recent years, there has been significant advances worldwide in the scientific understanding of critical factors and approaches for successful mangrove restoration (Erftemeijer and Lewis, 2000; Lewis, 2005; Lewis, 2009; Balke et al., 2011; Winterwerp et al., 2013; Erftemeijer et al., 2018; Erftemeijer et al., 2020; among many others).

There is now greater appreciation of the importance of physical, hydrological, chemical and ecological factors that determine the success of mangrove planting efforts, even in harsh and marginal (semi-arid and arid) environments. Community participation can also be particularly beneficial in ensuring successful implementation of the restoration effort and gaining a sense of ownership to look after the site and follow-up management of the mangroves (Erftemeijer and Bualuang, 2002).

Given significant successes with mangrove planting in parts of Tarawa previously, the abundant availability of propagules at several healthy stands of mangroves on the island, but a lack of natural recruitment into intertidal areas at various places along the coast of South Tarawa, as well as increased learning from recent research to address challenges in mangrove restoration in extreme environments, the support from local community groups, and the potential benefits it would generate in protecting the island from the growing threat of sea level rise, there is scope for further mangrove planting in Tarawa (Kiribati).

Figure 4. Recently planted saplings of *Rhizophora stylosa* on Tarawa (with some older stands in the background).

3. MANGROVE PLANTING

General considerations

Before moving straight into planting of mangroves, it is critically important to first assess the reasons for the loss or absence of mangroves in the area. Unless the underlying root causes for the loss or absence are first understood and addressed, planting of mangroves at such sites is highly unlikely to succeed.

For any mangrove restoration project, five critical steps are necessary to achieve a successful outcome (Lewis, 2005):

1. Understand the autecology (individual species ecology) of the mangrove species at the site, in particular the patterns of reproduction, propagule distribution and successful seedling establishment
2. Understand the normal hydrological patterns that control the distribution and successful establishment and growth of the targeted species
3. Assess modifications of the original mangrove environment that currently prevent natural secondary succession (recovery after damage)
4. Design the restoration program to restore appropriate hydrology and, if possible, utilize natural volunteer mangrove propagule recruitment for plant establishment
5. Only utilize actual planting of propagules, collecting seedlings, or cultivated seedlings after determining (through steps 1-4) that natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization, or rate of growth of saplings established as objectives of the restoration project.

When to plant mangroves

The timing for mangrove planting will depend on the availability of propagules. In Tarawa, propagules are generally abundantly available during August - October. Ripe propagules can either be planted directly into the substrate at a restoration site, or first grown up in a mangrove nursery for several months before planting. Although involving additional labour and time, nursery-grown seedlings tend to show higher survival rates in mangrove planting programs.

Common reasons for failure

Some common reasons for failure of mangrove planting include:

- Use of inappropriate methods
- Insufficient information
- Inadequate site selection
- Planting of the wrong species
- Inadequate monitoring of seedlings
- Failure to involve communities
- Poor coordination among institutions
- Decision makers' lack of awareness

Reports on previous mangrove restoration projects at Tarawa further noted poor survival of planted propagules due to low soil nutrients, lack of freshwater, barnacle infestation, seaweed entanglement and poor drainage (Baba et al., 2009).

Pilot trial before large-scale planting

It is wise to first conduct some small-scale pilot trials to test site suitability and gain familiarity with planting methodology and logistics, before implementing large-scale planting programs. Large-scale restoration efforts are also more likely to be ecologically meaningful, with measureable ecosystem effects over time.

4. PLANTING METHODS

Recommended method for Kiribati

The method recommended and tested to be the most suitable method for the planting of *Rhizophora stylosa* in Kiribati is described below. It is recommended to follow the following general guidelines when implementing this method:

- Collect propagules of *Rhizophora stylosa* from existing healthy, mature mangrove stands (e.g. around Buota in North Tarawa) during the right time of the year (e.g. September/October), when they are abundant and ripening. Ripe propagules can be recognised as those that are beginning to colour brown and protrude from the fruit, with the tip of the propagule (just below the fruit) turning white (see photograph below). Collecting from multiple sites is recommended to enhance genetic diversity of the stand.

- Grow up seedlings from the propagules in a village nursery near the intended restoration area (preferably in a shaded area, e.g. under a large tree in the village or in-between adjacent houses)

- Use poly-bags or plastic bottles (lower half) filled with sand (if available, add some organic material, e.g. coconut fibre, to the sand as a soil enhancer) to plant the propagules. Plant three propagules close together in each pot.

- Water the propagules/seedlings daily (or twice daily) with freshwater during the first month, with freshwater (one day) and seawater (next day) alternating during the second month, and with seawater only thereafter

- The seedlings will be ready for out-planting after 4 to 6 months in the nursery (by that time they will have developed leaves and roots)

- Plant the seedlings in narrow rows between mean water level (MWL) and mean high water level (MHWL) in an area that is considered suitable for mangrove growth (sheltered, showing (fine) sediment accumulation, the presence of crab holes is a good sign

- Spacing of 50 x 50 cm is recommended, based on previous experience in Tarawa (Baba et al., 2009; Baba, 2011)

- Seedlings (when out-planted) will have a greater chance of survival than propagules and will be able to anchor themselves within a relatively short timeframe (which can be advantageous in areas that a more exposed to tidal currents and some wave energy)

- In areas subject to the impact of significant wave energy, it may help to construct some low-tech (improvised), temporary 'hybrid engineering' structures to create shelter from the waves to make sure that the seedlings are not swept away with the first available high tide.

- This can be achieved in various ways, e.g. with sand bags constructed from old copra bags, filled with sand from the area and placed in a way to reduce wave impact while still letting water through ('permeable barriers'), or using heaps of rocks and/or logs.

- Patience is required to allow the mangrove to develop and grow; after 3 years they will typically have grown to about 1.2 m high, with approximately 50% survival (Baba, 2011)

- Challenges reported for Tarawa (which may result in some mortality among the planted seedlings) include poor soil conditions (low in nutrients), lack of freshwater, wave exposure, erosion, sedimentation, barnacle infestation, seaweed entanglement and poor drainage, resulting in stagnant pools of water at low tide (Baba et al., 2009).

Community participation

Effective community participation can greatly contribute to achieving local ownership and long-term sustainability of the outcome of a mangrove planting project beyond the initial intervention. This will be particularly so when the community is (made) aware of the values of the restored mangrove ecosystem as coastal protection asset and fish habitat and thus its contribution to securing a better livelihood and future.

It can also play a factor when weighing skill and experience against costs for the implementation of a project's planting objectives. Participation of local communities in Tarawa can also be instrumental in the establishment of village nurseries (as described above), which requires daily care, watering and maintenance.

Expectations

It is important to manage realistic expectations of the outcome of restoration efforts. To achieve this a clear communication strategy is critical. If there is a restoration pilot trial, then it needs to be viewed as it is, i.e. an experiment and learning process, to be scaled up and modified over time, with transparent sharing and learning of failures and unexpected developments along the way to determine what works and what doesn't.

The outcome of a pilot trial will define whether a full restoration program is worth pursuing. Expectations may be too high if people expect and conclude that a particular restoration approach will be successful without any prior learning experience and/or proven demonstration of success under similar circumstances (or from earlier pilot trials at the site).

5. MONITORING & EVALUATION

Implementing a systematic monitoring plan to document the progress, challenges, effect of remedial measures and ultimate degree of success of the restoration is an essential component of any mangrove planting project.

Although monitoring can be labour-intensive and expensive, a systematic and statistically robust monitoring program using standard methodologies is indispensable not only for measuring success but also as a basis for 'mid-course' corrections (e.g. remedial planting, site modifications) and for deriving valuable lessons for improved planning of future seagrass restoration initiatives.

It is good practice to link the monitoring of the performance of planted mangroves to agreed standards and pre-defined metrics. Success should be evaluated against clearly defined success criteria that are preferably quantitative and scientifically valid. Success criteria can be as simple as the extent of planted area (in hectares) or a desired percent survival or %cover of the mangrove vegetation and its persistence over time.

Monitoring programs for mangrove planting programs are best run for a duration of at least three to five years, with quarterly or half-yearly monitoring in the first year (to allow for remedial action and modifications, if required) and then annually in the remaining years.

Monitoring during the first 3-6 months:

• *Qualitative inspections at planting site*: Weekly visual inspections of the planted mangroves to see how they are doing. Make notes of significant issues, such as erosion, burial, algal smothering, mortality or loss of seedlings and damage to sand bags, but also positive developments, such as appearance of crabs & other fauna (incl. birds) amongst the mangroves;

• *Mitigating measures:* Remove any unwanted debris, plastic and accumulations of macroalgae that may have been washed into the site and could potentially damage or smother the mangrove seedlings. Human disturbance (e.g. deliberate trampling, uprooting of seedlings or removing of sand bags) should be prevented through awareness and enforcement.

• *Nursery re-stocking*: Collect new propagules from mature natural mangrove stands to grow up new batches of seedlings in village mangrove nurseries for later use to replace seedlings that have died or washed away and for future planting efforts.

Monitoring after 6 months, 1 year and annually thereafter:

• *Detailed analysis of the performance of the mangrove plantation*:

- Count and record the total *number* of living mangrove seedlings or saplings and dead seedlings at the site;
- Measure the *height* of all mangrove seedlings/trees (or of as many as

possible, at least 30) using a ruler or measuring tape.

- Record the total number of *leaves* of at least 30 of the seedlings / saplings (that are alive)
- Record the *diameter of the stem* (using a simple calliper) of at least 10 randomly selected mangrove seedlings/saplings
- Record the presence and numbers (per mangrove 'plant') of *stilt roots* and their condition (measure their (max) diameter for ~10 of them, using a simple calliper);
- Record *gastropod snail densities* and crab hole densities (if present) on the substrate among the mangroves (in 25x25 cm quadrats; at least 10 random counts);
- Record any *other noteworthy observations*, such as flowering, production of propagules, (other) associated fauna, overgrowth by macroalgae (estimate % if possible), presence of significant quantities of debris/litter, physical damage or evidence of other obvious human disturbances; qualitative description of sediment type/condition
- Take *photographs* to document the observations (especially of the extent and health of the mangrove seedlings and the overall plantation, as the seedlings further develop and the mangrove vegetation expands over time).

The results of the monitoring should be used to evaluate the success of the mangrove planting, derive lessons learnt and help in the planning for future mangrove planting programs. Sharing of the experiences and results of the mangrove planting program and its monitoring results is encouraged (e.g. through dissemination of reports, community meetings, presentation at workshops, and scientific publication).

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