In situ conservation of mangroves species in Bagan Datuk, Perak

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Abstract. In situ conservation is one of the methods recommended for conserving forest genetic resources. It aims to maintain and recover viable population of species in its natural habitat, to reintroduce the rare and endangered species and to recreate the habitats for plant species. Though mangrove rehabilitation programmes are widely carried out in Malaysia, the most common species planted for this purpose have always been Rhizophora apiculata (Bakau minyak) and Rhizophora mucronata (Bakau kurap). In this study, mangroves species namely Bruguiera cylindrica (Berus-berus), Ceriops tagal (Tengar), Xylocarpus granatum (Nyireh bunga), Xylocarpus moluccensis (Nyireh batu) and Sonneratia ovata (Gedabu) were planted in Bagan Datuk Mangrove Germplasm, Perak. These species were selected due to their unavailability in the study area. The main objective of this study is to rehabilitate and to introduce new species in the Bagan Datuk Mangrove Germplasm area. The initial growth and survival of saplings planted were measured and data obtained were analyzed using SPSS program. After 12 months of planting, the survival rate was 80% and Sonneratia ovata recorded the highest mean height increment.

Keywords: Mangrove; in-situ conservation; rehabilitation; germplasm; growth rate.

1. Introduction
Mangrove forests comprised of unique plant species that form the critical interface between terrestrial, estuarine, and near-shore marine ecosystems in tropical and subtropical regions [1]. The loss of individual mangrove species is also of great concern, especially as even pristine mangrove areas are species-poor compared with other tropical plant ecosystems [2]. To preserve mangrove diversity it has become essential to establish mangrove genetic resources in a form of germplasm. Germplasm is live information source for all genes present in the respective plant, which can be conserved for long periods and regenerated whenever it is required in the future. Apparently, there is a little research study conducted on mangrove germplasm.

Germplasm conservation may be ex situ, in seedbanks or other genetic repositories, or in situ, on farms or in natural parks and reserves [3]. In case of this study, in-situ conservation was applied to conserve the new species in their natural habitats where in future the populations of species will exist naturally. The main objective of this study is to rehabilitate and to introduce new species in the Bagan Datuk Mangrove Germplasm area. The importance of establishing this mangrove germplasm with new species was to ensure that there is a continuous source of seeds of various species of mangrove as well as to prevent loss of genetic diversity [4,5]. Moreover, main economic activities of the community in Bagan Datuk are fishing and farming. Ecologically, the mangrove forest is a feeding and nursery ground for around 60% of fish that live in coastal fisheries [6]. Loss of mangrove forest area will affect the reduction of the population of marine life as well as reduce the income of the locals. Therefore, there is a need for new research regarding in situ conservation of mangrove species to conserve and enrich the ecosystem of mangrove area.

The reintroduction of this species was an approach to study the species-site suitability as well as to rehabilitate the mangrove area. In order to improve the success of rehabilitation, proper planning for rehabilitation, the use of edible seeds, and adjustment or adaptation of mangrove vegetation should be carried out in accordance with growth factors [7,8]. Thus, the initial growth and survival of saplings planted were measured and data obtained were analysed.
2. Methods
Bagan Datuk, Perak is located at the west coast of Peninsular Malaysia. Planting site is located within a newly established Bagan Datuk Mangrove Germplasm area (Figure 1). The planting site was previously cleared and used to place pipeline for nearby construction project. There are also trace of mangroves harvesting activities in the area. Thus, the objective of this study is to carry out an in-situ conservation through replanting mangroves species in the study area. The study area is considered to be in the landward zone of the mangrove ecosystem.

![Figure 1. Map of planting site located within the Bagan Datuk Mangrove Germplasm.](image)

A total of 300 saplings namely *Bruguiera cylindrica* (Berus-berus), *Ceriops tagal* (Tengar), *Xylocarpus granatum* (Nyireh bunga), *Xylocarpus moluccensis* (Nyireh batu) and *Sonneratia ovata* (Gedabu) were planted in a 1200 m$^2$ area. Species selections were conducted based on list of species that are currently unavailable in the area. Saplings were collected from mangroves area along the coastline of Peninsular Malaysia. Planting stocks were potted into an 8”x 8” polybag and maintained in the nursery for six months prior to planting. Planting activities were carried out in July 2020. Saplings were planted in 2 m x 2 m spacing, alternately between species. Wire-mesh fencing were installed around the saplings planted as protection against animal attack mainly long-tailed macaques which are abundant in the area.

Data collection includes survival and height of the saplings planted. The first data collection was carried out right after planting to obtain the initial measurements. Growth and survival of saplings were observed after 12 month. The growth rate is measured in term of mean height increment for each species using equation (1):

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\text{Mean increment} = \frac{\text{final measurement} - \text{first measurement}}{\text{total number of saplings for each species}}
\]
Basal diameter is not being measured as it would be difficult to determine the actual increment of basal diameter of saplings since sediment accretion and/or decrretion on reference measures would vary too much.

3. Results and discussion
After 12 months of planting, the overall survival rate of the planted saplings was 80%. *Sonneratia ovata* contributed to the highest survival rate (89%) and highest height increment meanwhile *Xylocarpus moluccensis* exhibited the lowest survival rate (72%) and the lowest height increment (Table 1).

| Species                  | Mean Height (cm) | Mean Height Increment (cm) | Survival (%) |
|--------------------------|------------------|----------------------------|--------------|
| *Bruguiera cylindrica*   | 81.00            | 4.41                       | 78           |
| *Xylocarpus moluccensis* | 77.77            | 1.71                       | 72           |
| *Ceriops tagal*          | 61.13            | 2.09                       | 83           |
| *Sonneratia ovata*      | 128.88           | 7.23                       | 89           |
| *Xylocarpus graminum*    | 99.07            | 1.93                       | 78           |
| **Overall Survival**     |                  |                            | **80%**      |

Generally, mangroves species are able to grow in a wide range of environmental conditions despite having its own range of tolerance to different attributes along their natural habitats [9]. In most cases, the seedling grows better where the mother trees are found compared to when introduced in a new mangroves area [10]. In this study, the five species were introduced in a mangroves area where no mother trees of their species were available, yet the survival rate and growth performance is promising. This is also shown in other study findings that species such as *Sonneratia ovata* able to adapt well when introduced in new mangrove area [9]. In term of height increment, some mangrove species does show a different growth rates in response to topography [11]. Despite, the planting activities were carried out in the right zonation of the species, further study on different level topograhy is needed to conclude which species has the best growth performance. Other than that, longer time frame for data collection would probably give a better conclusion on the growth rate of the introduced species in the area. For example, there are study that recorded high survival rate at the early stage of the planting but the rate decrease rapidly after more than a year [11].

On the other hand, while the effort of conserving and restoring mangrove forest in Malaysia has been immense especially post 2004 tsunami, common species such as *Rhizophora apiculata* and *Rhizophora mucronata* are mostly used for planting activities due to easily obtained seedlings. However, in term of in situ conservation and mangrove restoration, species diversity needs to be considered. Mixed species planting should be considered in mangrove restoration rather than only focusing on common species such as *Rhizophora* sp. [5], especially in less diversified area. For example, even though *Bruguiera cylindrica* has been recorded to have a limited distribution and only found in West coast of Peninsular Malaysia [12] but it was not found in Bagan Datuk which was also located in the west coast of Peninsular Malaysia, thus reflect the low distribution of species in the area.

In establishing a mangrove germplasm through in situ conservation, species diversity would be the main concern. While there is continuous effort to collect seedlings and saplings from all over Malaysia, some of the key points to consider are that some species of mangroves are protected, while some are endemic. There will be some conflicting issue in this effort that need to be tackled.

4. Conclusion
This in situ conservation effort is a small start in establishing a mangrove germplasm in Bagan Datuk. While this study only shows the preliminary result of introducing new species in Bagan Datuk mangrove forest, further data collection and investigation on other ecological attributes is highly recommended. At the moment, *Sonneratia ovata* can be considered to have high resiliency when introduced in a new area.
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