

## The Ranong Biosphere Reserve: History, Objectives and Management Experiences

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### ABSTRACT

The Man and the Biosphere programme and the associated World Network of Biosphere Reserves were initiated at a United Nations conference in 1968. Since then, the programme has evolved considerably but has retained its key focus on research, management and education relating to the interaction between humankind and nature. The Ranong Biosphere Reserve was nominated in 1997, and was one of the first biosphere reserve nominations following the adoption of the Seville Strategy and Statutory Framework, which outline in detail the role and spatial organization of modern biosphere reserves. The Ranong Biosphere Reserve is home to one of the region's most extensive mangrove forests, as well as a number of other important coastal ecosystem types. The reserve is managed by the Ranong Mangrove Forest Research Center, which is active in conservation, research, rehabilitation and education activities. In order to ensure the successful implementation and further development of the Ranong Biosphere Reserve, a number of recommendations for management action at the local and national level are made.

**Keywords:** Biosphere Reserve, spatial organization, mangroves

### INTRODUCTION

To their simultaneous advantage and detriment, the Man and the Biosphere (MAB) programme and the associated World Network of Biosphere Reserves (WBRN) are highly complex mechanisms. MAB is at the same time a global UN framework based on voluntary cooperation rather than a convention; as well as a programme based simultaneously on cutting-edge interdisciplinary science, local government structures, and international networking.

This complexity sometimes makes it difficult to grasp what exactly the programme is all about. The question "what is a biosphere reserve?" necessarily leads to a long response in which historical perspectives of the programme, its current interpretation, and its application in the local context is detailed in order to provide the most accurate description.

Ultimately, a complex answer is necessary because each *actively implemented and up-to-date* biosphere reserve is a uniquely local entity, developed in accordance with local interests, needs and priorities, functioning according to the most appropriate local mechanisms; and spatially organized according to the local natural, social and human conditions.

However, the complexity has other causes too: for several years, MAB was unique among international cooperative frameworks on protected

areas in combining scientific research, education, spatial organization, management, and sustainable development as priorities in its work. While the rest of the world has to a wide extent caught up with MAB today, MAB remains an ambitious and inherently complex programme due to its focus on bringing together the world scientific community while at the same time addressing local management issues.

The Ranong Biosphere Reserve was created at a critical time in MAB's history, immediately following the adoption of the *Seville Strategy* and *Statutory Framework* – documents that continue to define the MAB programme today. The Ranong nomination was ambitious, requiring a sustained effort at local, national and international level to secure its successful implementation.

This paper will discuss the evolution of the MAB programme and the place of the Ranong Biosphere in today's World Network, as well as examine in detail the Ranong Biosphere Reserve and the implementation of the concept to date.

### Brief historical context

The Man and the Biosphere programme emerged in the late 1960s, in the context of a rising concern in the international debate over the environmental impacts of the rapid economic development experienced in some parts of the world. In 1966, UNESCO – as the UN specialized agency

responsible for the natural sciences - was asked to take the lead in organizing an intergovernmental conference on the “rational use and conservation of the resources of the biosphere”.

A high-level conference – commonly known as the *Biosphere Conference* - was held in Paris in 1968 in response to the request. While this event has been somewhat overshadowed by the Stockholm 1972 *United Nations Conference on the Human Environment*, many of the issues covered by the Stockholm Conference were matters that had originally been raised at the Biosphere Conference.

The word “biosphere” was defined by the 1968 Conference as: “*that thin shell at the interface of the atmosphere, hydrosphere and lithosphere where life and its products exist; that living organisms manifest their characteristics by constant interrelations with the environment; and that in doing so the interactions themselves create a degree of systematic order*” (UNESCO, 1968).

The Biosphere Conference made two assumptions that were to hold particular significance for the development of the MAB programme in the subsequent years:

1. That the natural sciences were in a position to produce the information required for “wise” decision-making and “rational action” relating to human use of the biosphere; and
2. That – due to humankind’s role as a “key component of the biosphere” - the natural sciences *alone* would not provide the conditions to ensure that wise decision are taken

In other words, early MAB planners concluded that while science-based information is essential to solve problems relating to the way in which humanity uses natural resources, science alone would not be enough. This duality, placing science at the core of the MAB programme agenda, and at the same time placing that science in a wider and more complex context, persists to this day as a defining feature of the MAB programme.

The Biosphere Conference proposed, as one among a number of recommendations, that an “*international and interdisciplinary programme on the rational utilization and conservation of the resources of the biosphere be prepared for the good of mankind*”. This recommendation led to the establishment of MAB in 1970.

The general objective of the newborn programme was established at the first session of its International Governing Council as “*to develop the basis within the natural and social sciences for the rational use and conservation of the resources of the biosphere and for the improvement of the global relationship between man and the environment, to predict the consequences of today’s actions on tomorrow’s world and thereby to increase man’s*

*ability to manage efficiently the natural resources of the biosphere.*” (UNESCO, 1971).

Among the first decisions of the MAB-ICC was the proposal of a series of 13 research projects for the nascent programme to undertake. The projects covered a range of topics in the areas of ecology, human impacts on particular ecosystems such as subtropical forests, pest management, industrialization, and more. It was one of these research projects - project number 8, “*Conservation of natural areas and the genetic material they contain*” - that eventually grew into the World Network of Biosphere Reserves.

Above all, in early discussions on the topic, biosphere reserves were envisioned as representative samples of the world’s biomes. The primary objective of the establishment of the world network was: “to ensure that adequate examples of all important and representative biome subdivisions are protected”.

It was hoped that this approach – by which the areas under protection would be identified on the basis of their representativeness of a given biome rather than by other criteria (such as for example flagship species) would yield protection for plants and animals about which knowledge was still considered limited. In other words, biosphere reserves would secure in-situ conservation of genetic resources; known and unknown, as well as a baseline against which to assess human impact on the global environment. (UNESCO, 1973)

The first direct references to what was to become the characteristic biosphere reserve zonation system were also made at this time, noting that the value of the biosphere reserves “can be further enhanced if they can be surrounded by areas in which the natural ecosystems are managed as a resource”. From the outset of the concept’s development, the role of the biosphere was inextricably linked to the management of the surrounding areas. The difference between this discussion and the current interpretation of the biosphere reserve is that today’s biosphere reserves include the surrounding areas as an integrated component in the reserve itself. With these basic elements in place, a joint UNESCO and UNEP Task Force met in 1974 to elaborate a series of more specific selection criteria and processes for the establishment of biosphere reserves. While the Task Force elaborated a series of “characteristics” of biosphere reserves, and defined the core-buffer zonation system as well as stressed the need to ensure appropriate, integrated management of biosphere reserves, the task force did not specify a concise definition of a biosphere reserve.

The first nominations of biosphere reserves were made in 1975 by UNESCO member states

through dedicated MAB National Committees, which had been established to serve as the linkage between UNESCO and the MAB programme's activities at the national level. Included in the small very first group of Biosphere Reserves was Sakaerat in Thailand<sup>1</sup>. By 1977, 118 biosphere reserves had been established in 27 countries, and the programme was on its way to becoming a global undertaking.

In 1983, the First Biosphere Reserve Congress was held in Minsk in Belarus (then part of the U.S.S.R.). The Congress produced an Action Plan that clearly demonstrated the degree to which the concept of the biosphere reserve had evolved by the early 80s. Among the characteristics defining a biosphere reserve, it was now clearly noted that each reserve was expected to comprise of a formally protected core zone (containing the genetic resources with which the site had been associated and considered worthy of protection), and a buffer zone, which could extend into a broader undelineated wider area (what was later termed the transitional area). The Action Plan also referred to complex zonation systems such as "clusters" of zones within each biosphere reserve, although this was not presented in great detail.

The concept of the biosphere reserve came fully into its own with the adoption of the *Seville Strategy and Statutory Framework of the World Network of Biosphere Reserves* at the International Conference of Biosphere Reserves held in Seville, Spain, in 1995, and their subsequent adoption by the UNESCO General Conference the same year. The Strategy and Statutory Framework jointly comprise the basic set of recommendations and guidelines that govern what a biosphere reserve is and does<sup>2</sup>.

In the Strategy and Statutory Framework, the spatial organization and management of biosphere reserves were brought to the fore – the zonation scheme (comprising core zone(s), buffer zone(s) and transitional area), and three functions of the biosphere reserve (conservation, development, and logistic support), for example, were explicitly and precisely listed in the Statutory Framework. Also referred to in the Seville documents was the necessity to secure that appropriate management arrangements were put in place.

### **The Ranong Biosphere Reserve nomination**

There is no doubt that the Seville conference and the documents developed there represented a powerful input of new energy and enthusiasm into

the World Network, and that is influenced subsequent biosphere reserve nominations - one of the first of which was Ranong.

Being among the first post-Seville biosphere reserve nominations, it would have been considered essential - by both national authorities and UNESCO - that the Ranong nomination lived up to the expectations of clear and locally appropriate zonation, management arrangements, and fulfillment of the three functions – all among the basic tenets of the Seville documents.

From 4-8 November 1996, the Thailand National MAB Committee organized the *Regional Workshop on Designing and Establishing an International Coastal and Marine Biosphere Reserve in Ranong Province, Thailand*. The event was supported financially through the UNESCO Participation Programme, with participation by an expert from the UNESCO Jakarta Office – testimony to the significance placed by UNESCO on Ranong as a key post-Seville nomination. The week-long workshop, during which national and international researchers came together with administrators and community representatives to comment and revise the nomination, resulted in the preparation of a successful nomination dossier that was seen as fully living up to the new standard for nominations set by Seville.

In fact, the procedure was considered so successful that the approach taken – i.e. developing the nomination documents through an international/regional workshop process – was both advocated and applied by UNESCO member states in the region for subsequent nominations such as the Can Gio Biosphere Reserve in Vietnam, and the Puerto-Princesa Subterranean River National Park World Heritage site.

While on paper a "model" post-Seville biosphere reserve, sustained adherence to the principles upon which the reserve was established has not been without problems. A number of factors have contributed to this situation; however, it is our opinion that the flows of communication and local-national coordination arrangements are the key factors in this. In order for an individual site to benefit from its association with MAB, which is an intergovernmental programme, it is essential that all key stakeholders at the local level are actively engaged in the biosphere reserve management process, so that they experience first-hand that the designation as a biosphere reserve *makes a*

<sup>1</sup>The majority of the early biosphere reserves were located in the United States – a very active participant in the programme's early years.

<sup>2</sup> It is important to note in this connection that MAB is not an international convention – it is a voluntary

intergovernmental framework of cooperation, which relies in essence on the goodwill of its participating actors at the local, national and international level

*difference* in the local setting. Once such a momentum is present – and there are several examples of this gradually being attained at the local level, even without national government contributions – it is essential that the developments are communicated to a clearly defined national MAB focal point or committee.

As an intergovernmental programme, MAB relies on its national committees and/or focal points as the main channel of communications in each member state. Again at this level, it is essential that the actors involved clearly sense that the biosphere reserve is managed according to biosphere reserve principle, communicates frequently and actively with the national counterpart body, which on its part actively takes part in the global MAB network, as well as coordinates promotion and public awareness of MAB at the national level. In summary, the following are key elements for the successful implementation of the biosphere reserve concept:

1. Active, integrated management of the biosphere reserve involving all key stakeholders at the local level – for example through a regularly meeting management committee with a clearly defined chairperson
2. Active, clearly defined national MAB focal point or committee
3. Regular communication through clearly defined channels between the individual biosphere reserve and the national MAB focal point and/or committee

The second section of this paper will discuss the implementation of the Ranong Biosphere Reserve in greater detail. However, before turning to this, we will briefly examine the latest developments of the MAB programme and their potential implications for Ranong.

### **The Madrid Congress: biosphere reserves today**

At the time of writing, 531 biosphere reserves have been established in 105 countries, and 40 years have passed since the “Man and the Biosphere” idea was first conceived. Building on the experiences and achievements of the Minsk and Seville congresses, UNESCO in cooperation with the Government of Spain organized the 3<sup>rd</sup> World Congress of Biosphere Reserves in Madrid in February 2008.

Madrid produced two key documents – a brief Madrid Declaration and a longer Madrid Action Plan. The Madrid documents do not represent a departure from the Seville Strategy and Statutory Framework, which continue to form the key reference documents for the World Network. However, the Madrid documents do add a series of new perspectives to the work and functioning of biosphere reserves – linking biosphere reserves closer to current initiatives and

targets such as the Millennium Development Goals and the UN Decade on Education for Sustainable Development, and stressing climate change research, mitigation and adaptation as a new area of focus for biosphere reserves.

In essence, the Madrid Action Plan calls for stronger implementation of the biosphere reserve concept, in recognition of the fact that - while the Seville documents provide the basic framework for implementation of the biosphere reserve concept - the application of the Seville principles and their sustained implementation at the individual country and site level are not given. The Madrid documents also seek a closer affiliation of the World Network with UN development targets such as the Millennium Development Goals. Finally, they encourage biosphere reserves to stress new and emerging issues of significance to the role of biosphere reserves. Among the dominant issues in this regard are:

1. Climate change: Biosphere reserves as demonstration sites for climate change adaptation measures, and through the world network contribute to global observation of climate change.
2. Ecosystem services: Active and continuing consultations between key actors in biosphere reserves may be critical in finding the optimal mix of ecosystem services that would illustrate the role of biosphere reserves as models for land/seascape level sustainable development at the national, regional and global levels.
3. Urbanization as a principal driver for ecosystem-wide pressures through rapidly changing and spatially shifting population densities, in particular migration from rural to urban zones

Among these, the first two may be of particular interest to the Ranong Biosphere Reserve.

### **The Ranong Biosphere Reserve – key features**

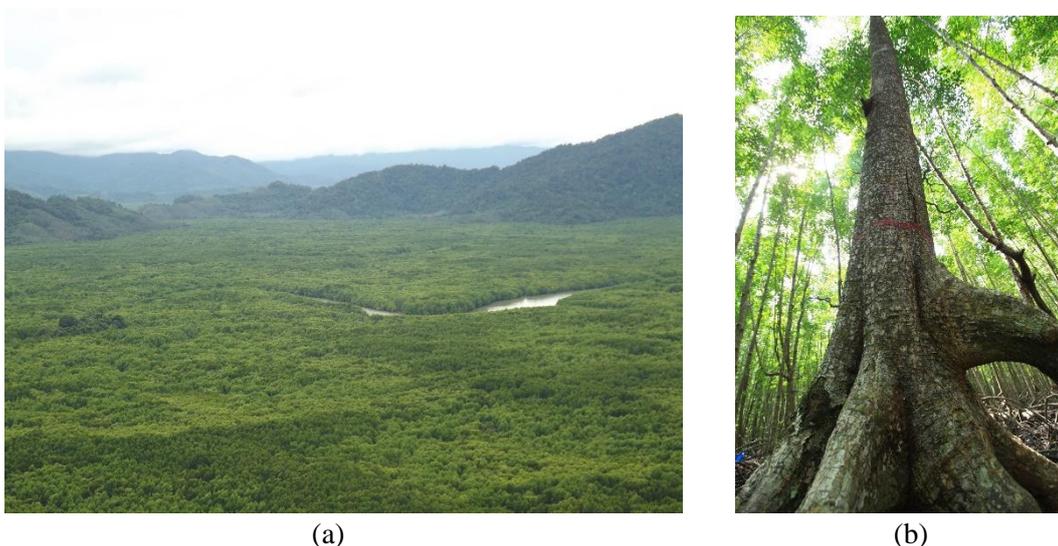
The Ranong Biosphere Reserve is located in Ranong Province, in the south of Thailand on the west coast of the Malay Peninsula, 650 km south of Bangkok and 300 km north of Phuket. Ranong province is Thailand’s least populous province, renowned for receiving the highest annual rainfall in the country. The main industries in the province are fisheries and the production of rubber, cashew nuts and fruits. The Ranong Biosphere Reserve covers an area of 30,309 ha, south of the township of Ranong. The mountainous Ngao Waterfall National Park forms the eastern boundary of the reserve, which borders the Andaman Sea to the west. Key ecosystems and features of the Ranong Biosphere Reserve include:

*Mangrove Forests:* The reserve incorporates a large proportion of the mangrove forests of Ranong

Province (Figure 1a). These luxurious forests grow in the soft muddy soils of the Kra Ruri River delta, on the border of Thailand and neighboring Myanmar. The mangrove forests of Ranong province are one of the largest parts of mangroves in Thailand (Meepol, 2011).

The mangrove forests in the reserve are mostly secondary forest, having been previously

harvested for the production of charcoal; formerly a major industry in the area. The virgin old-growth forests that remain are now reserved for research purposes. One area in the reserve at Had Sai Khao comprises a stand of *Rhizophora apiculata* trees estimated as being 200 years old (Figure 1b). Some of these trees reach up to 35m in height and over 2m in circumference at breast height.



**Figure 1** Mangrove forest in the Ranong Biosphere Reserve (a) and the 200-years old *Rhizophora apiculata* (b).

The reserve contains more than 50 species of mangrove trees, shrubs and vines: the most common being *Avicennia alba*, *Bruguiera cylindrica*, *B. parviflora*, *Ceriops tagal*, *Rhizophora apiculata*, *R. mucronata*, *Sonneratia alba* and *Xylocarpus granatum*.

Mangrove forests are important for their vital role in the coastal food chain, providing a source of food for many marine animals as well as providing shelter for young shrimp, crabs and fish in their complex roots systems. In this way, mangrove forests support Ranong's fishing industry, providing employment, food and other economic benefits for a large number of people. Mangroves in the reserve are also important source of wood, which local people use to construct their houses and fishing equipment and as fuel material for cooking. Furthermore, the mangroves serve to maintain coastal water quality by trapping sediments and filtering nutrients carried down by the river systems. Finally, mangrove forests in the reserve protect the coast from erosion during the southwest monsoon season.

**Tropical rain forest:** A further fascinating feature of the Ranong Biosphere Reserve is the tropical rain forest. These forests are scattered throughout the reserve; on islands rising high above the mangrove forests and further inland interspersed by agricultural and urban land. The main tree species

found in the tropical rain forest are *Dipterocarpus spp.*; *Anisoptera spp.*; *Shorea siamensis*; *Hopea ferrea*; *H. odorata* and *Dillenia spp.*

**Seagrass beds:** Seagrass beds are located in isolated patches throughout the reserve. These beds are comprised of *Enhalus acoroides*; *Cymodocea serrulata*; *Halophila ovalis* and *Halodule uninervis*. Seagrass beds are important for juvenile fish, prawns and other small animals, playing a role similar to mangrove forests, providing them with food and a place to live. They also hold the muddy soils together protecting against erosion and provide a source of food for the endangered dugong and some types of sea turtles.

**Urban and agricultural land:** Areas of urban and agricultural land in the reserve lie in the narrow coastal plain between the mangrove forests and the Ngao National Park. Fifteen villages are located within the reserve boundaries; five of these based within the mangrove forests.

**Local population and economic activity:** The population of the reserve is made up of people of predominantly Buddhist and Muslim religion; the only exception being a village on the western side of Koh Lao island which is occupied by "Chow Ley" or "Sea Gypsies" (Figure 2) who practice an animist religion. Villagers living within the mangrove forests predominantly make their living from catching mud crabs, small *Acetes* shrimp and small

pelagic fish. Some villages are also involved in the production of shrimp paste and cultivation of fish in cages in the mangrove canals. Villagers living landward of mangrove forests predominantly derive their incomes from the growing of fruit, rubber and cashew nut and shrimp farming which occurs within



(a)



(b)

**Figure 2** Local people inhabit in the reserve (a) and Sea Gypsies settle at Koh Lao (b).

*Wildlife habitat:* The reserve is home to a diverse wildlife population. Mammals that can be seen when visiting the reserve include otters, bats, crab eating macaques, tree squirrels, and civets. Endangered dugong and dolphins have also been sighted in the area. Reptiles found in the reserve include turtles, monitor lizards and many species of land and sea snakes. The diverse range of habitats in the reserve attracts a multitude of bird species, many species migrating here from other parts of Thailand and from overseas to breed and raise their young. Most commonly sighted species are the king fishers, hawks, bee-eaters, egrets, herons, kites, plovers and ducks.

*International Research:* The Ranong Biosphere Reserve is home to the Ranong Mangrove Forest Research Center in Ngao Sub-district, approximately 15km south of the township of Ranong. The Royal Forest Department opened this center in 1982. In 2002, the Royal Forest Department underwent a restructuring, during which the Ranong Mangrove Forest Research Center was transferred to a newly formed unit, the Department of Marine and Coastal Resources.

The objectives of the center are:

- 1) to conduct research and support the research projects of other research organizations within Thailand and overseas.
- 2) to disseminate information about mangroves ecology and
- 3) to encourage the conservation of mangrove forests.

Furthermore, the Ranong Mangrove Forest Research Center has been designated as the authority in charge of administrating the Ranong Biosphere Reserve. Over the years, the center has hosted many

and on the boundary of the mangrove forests. Large areas of the reserve lie abandoned after having been disturbed by tin mining, a major economic activity in Ranong until the mid 1980's. These areas are no longer suitable for agriculture due to the poor soil condition.

international research projects. Examples of research projects include the Japan-Thailand Collaborative Project "Ecological Equilibrium and Productivity of Mangrove Forest in 1991 was to study structure, biomass, nutrient cycling, water and soil properties. UNDP/UNESCO Project on Mangrove Management for Asia-Pacific countries, 1986-1989 worked on both research and training young scientists from the Asia-Pacific countries in many aspects of mangrove ecology. The European Union Project on Environmental Assessment (EA) of mangrove plantations for coastal protection and fisheries production (1994-1996). The number of research projects conducted in the reserve from 1982 to 2015 was 43 topics (Forest Research Center, 2016). These collaboration projects and research projects have greatly increased our knowledge of the mangrove ecosystem and its value. At present, the center is active in educating the local community about the environment and the value of mangrove forests, hosting many school and community groups and organizing community replanting days. Facilities at the center include an information center and boardwalk with interpretative signage focusing on the mangrove environment.

### Issues and management

In the past, Thailand's coastal environment came under pressure from overuse and unsustainable development. Thailand's mangrove forests have been badly degraded; their combined area reduced by almost 50% in the last 35 years. Ranong's coastal environment - although in relatively good condition - is experiencing problems with overfishing and the use of illegal fishing gear, illegal cutting of

mangrove forest, and the conversion of mangrove and upland forest for agriculture and shrimp farms.

As the biosphere reserve management agency, the Ranong Mangrove Forest Research Center plays an important role in educating local people, student and community groups about the value of the mangrove forests and the biosphere reserve concept, and in conducting research in mangrove ecology. Moreover, the center also plays an active role in the rehabilitation of degraded mangrove forests in the reserve.

The Ranong Biosphere Reserve is managed using a zoning system. The reserve is divided into three types of zones; core, buffer and transition zones. These zones are managed in different ways, in accordance with MAB guidelines (Figure 3):

The core areas are the most pristine areas of mangroves, bounded by the sea and mangrove canals.

These areas are conserved and only activities such as research and monitoring are allowed. The core areas have a combined size of 4,574 ha.

The buffer zone surrounds the core areas and is made up of former concession forest, some shrimp farm and former mining areas. This area is managed to provide a buffer between the core and surrounding areas. Some activities such as fishing, rehabilitation of mangroves and ecotourism are allowed. This zone has the total area of 19,400ha.

The transition area is comprised of areas converted for tin mining, agriculture, shrimp farming and urban development, and surrounds the core areas and buffer zone. This area is managed to reduce the impact of activities on the core and buffer zone areas in the reserve. It has the total area of 6,335ha.



**Figure 3** Zonation map of Ranong Biosphere Reserve (a) and the plaque of Ranong Biosphere Reserve (b).

### Future needs and recommendations for management

Management of the Ranong Biosphere Reserve is focused on education and conservation of the reserve area (Figure 4). However, the Ranong Mangrove Forest Research Center still lacks manpower and facilities. To develop the Ranong Biosphere Reserve following the biosphere concept, the following issues should be considered.

*Protection and rehabilitation:* The core areas - which are pristine mangrove forests - should be protected from illegal cutting. Therefore, a patrol unit should be established to protect the mangrove forest. This unit should be based with the research center and in the mangrove forest and equipped with full capacity such as speed boat, long tail boats and manpower. In the buffer zone, the rehabilitation of degraded mangroves is needed. Fortunately, the government proposed a total log ban in mangroves in 1996 and the last concession mangrove forest in Ranong was in 2002. The government - through the Department of Marine and Coastal Resources - is currently making efforts for the rehabilitation of degraded mangroves from former concession forests

in the whole country. It is hoped that the condition of the reserve's mangroves will be improved as a result. At present, the rehabilitation project in the degraded mangroves in the Ranong Biosphere Reserve is almost complete.

Therefore, it is being considered to focus the management of mangrove resources only on tending such as the replanting of mangrove seedling if survival rate is not meets the minimum requirement, removing of weeds and debris during early stage of mangrove plantation. It is also being considered to the sustainable use of fishery resources including the protection of mangroves from illegal cutting.

*Infrastructure:* The Ranong Mangrove Forest Research Center should provide facilities to promote the Biosphere Reserve to the public such as boardwalk, pier, canopy watch tower, interpretative signboards, etc. The Center has already established a boardwalk (Figure 5). However, these still need improvement as they are made from wood that is not suitable in areas with such high rainfall.

*Involving local communities:* There are several villages settled in the mangroves around the reserve.

Therefore, it is necessary to ensure that these communities participate in conservation and utilization of the reserve's natural resources. Towards this, the center should provide a community forest for the community to utilize mangroves for wood consumption, or issue guidelines for utilization of

natural resources. The center should establish a biosphere reserve committee to handle all the issues related to the biosphere reserve and also use this platform to solve the problems in managing the biosphere reserve.



(a)



(b)

**Figure 4** Plantation of 3-year-old *Rhizophora mucronata* in the reserve and the school children planted the mangrove seedlings (b).



(a)



(b)

**Figure 5** Boardwalk in the reserve (a) and signboards set up along the boardwalk (b).

**Research:** The Ranong Mangrove Forest Research Center has conducted research in mangrove ecology since its establishment in 1982. There are many ongoing research projects including the research collaboration with overseas institutions. However, research in the past has focused on specific fields. The reserve needs to elaborate further research programmes as well as a development plan for the Ranong Biosphere Reserve. This should include the establishment of a laboratory and nursery to support research in the mangroves.

**Ecotourism:** The Ranong Biosphere Reserve plays an important role in local ecotourism (Figure 6). The reserve receives an average of more than 10,000 visitors per year. The number of visitors is increasing. However, the reserve should provide the information center and – as noted - improve the boardwalk and provide boats for visitor to rent. Moreover, the reserve could develop the mangrove museum to include the management of mangrove forest and the diversity of mangrove fauna and flora.



(a)



(b)

**Figure 6** Students visit the research center (a) and foreigners visit the center (b).

*International cooperation and support:* The Ranong Mangrove Forest Research Center has hosted many international research projects in the past which have greatly increased our knowledge of the mangrove ecosystem and its value. The Ranong Biosphere Reserve should continue collaborative research projects with foreign countries in order to further increase the knowledge of mangrove ecosystems. Finally, the biosphere reserve could also serve as a centre for research on climate change and global warming issues.

### Management Experiences

Ranong Biosphere Reserve is one of only four biosphere reserves in Thailand and it is protecting a major part of Ranong Mangroves. Ranong Biosphere Reserve designated in 1997, there are many aspects have been developed within the biosphere reserve. The following issues are as follow;

1. The clear zonation: Ranong Biosphere Reserve has a clear zonation based on three zones; core area, buffer zone and transition area. The core area is conserve for biodiversity, buffer zone is protect the core area and serve as environmentally compatible livelihood activities of people living in the buffer zone, which are mainly based on fishery and aquaculture. The transition area is outside the buffer zone which serves as human settlement and agricultural area. There are no illegal mangrove cutting and also no illegal fishing practices in the reserve.

2. The mangroves have been improved: The government implemented the management measures for mangroves such as cancellation of logging in mangroves, rehabilitation measure, protection measure such as digging the canal to separate the mangrove area from private land and patrol the mangroves and conservation measure which is educate local people to conserve the mangroves and bring the locals to participate in planting activity in the reserve. These help to develop the local network in conservation of mangroves in the biosphere reserve. Apart from these, the government also

declared the Mo Ko Ranong National Park in 2009 which covers two third of Ranong Biosphere Reserve boundary. This also helps to protect the natural resources in the reserve. The government also established the Mangrove Development Station No.10 (Muang Ranong) to take responsible in rehabilitation, protection and conservation of mangroves in Ranong Biosphere Reserve. Therefore, there are three offices involving mangrove resources; Ranong Mangrove Forest Research Center, Mangrove Development Station No.10 (Muang Ranong) and Mo Ko Ranong National Park.

3. Mangrove rehabilitation: The rehabilitation of mangroves in the reserve is success and can serve as best practice for mangrove rehabilitation. The rehabilitation of mangroves in the reserve covers the area approximately 3,700 ha. The rehabilitation has been conducted in the degraded mangrove area, abandoned tin mining area and abandoned shrimp farm area. The species to be planted were *Rhizophora apiculata*, *R. mucronata*, *Ceriops tagal*, *Bruguiera* spp, etc. The guideline for rehabilitation of mangroves includes choice of species, site preparation, nursery technique, planting technique and tending. The rehabilitation of mangroves in the reserve is mostly planted in the gaps and open areas where the natural regeneration is absent due to lack of mother trees and the weeds occupy the area. The species to be planted are mix species depending on the present species occur in that area. However, in the abandoned shrimp farm area which is illegally occupied as shown in Figure 4 (a) mostly chose the *Rhizophora* species which is a fast growing tree and this species prefers the high water inundation.

4. International research: There has been a long history of mangrove research activities at the reserve involving collaboration between Thai scientists and students and research groups from Southeast Asian countries including Japan, Australia, USA and Denmark. This helps to increase knowledge in mangrove ecosystems.

5. The education center for mangrove: the Mangrove Forest Research Center plays an

important role in educating local people and school children in mangrove conservation for a long time since the inception of Ranong Biosphere Reserve. This helps to increase awareness in conservation of mangroves. The center constructed the boardwalk with interpretative signboard for mangroves. The center also introduced the ecotourism in mangroves.

6. Monitoring: The Ranong Mangrove Forest Research Center is also responsible in conducting research in mangroves. The center set up permanent plots for long-term monitoring the mangrove ecosystems both natural mangroves and mangrove plantations with different ages.

7. People participation: There are many villages which inhabit near the mangroves participate in conservation of mangroves such as planting activity, protection the mangroves which lead to the mangrove network in the reserve.

*The Future Management:* The Ranong Biosphere Reserve joins the World Network of Biosphere Reserve which consists of 701 sites in 124 countries worldwide. The management of Ranong Biosphere Reserve is followed the UNESCO's guidelines. At present the, MAB Programme is implementing the Lima Action Plan (2016-2025) which developed from MAB Strategy (2015-2025) (UNESCO, 2017) and the Madrid Action Plan (2008-2013). The Lima Action Plan comprises five strategic action areas which are;

1. The World Network of Biosphere Reserves consisting of effectively functioning models for sustainable development.

2. Inclusive, dynamic and result-oriented collaboration and networking within the MAB Programme and the World Network of Biosphere Reserves

3. Effective external partnerships and sufficient and sustainable funding for the MAB Programme and the World Network of Biosphere Reserve

4. Comprehensive, modern, open and transparent communication, information and data sharing

5. Effective governance of and within the MAB Programme and the World Network of Biosphere Reserve

It is interesting to note that the management of Ranong Biosphere Reserve need to follow the Lima Action Plan (2016-2025) as mentioned above. However, the management of each biosphere reserve worldwide will be evaluated every 10 years. Therefore, Ranong Biosphere Reserve needs to focus on the Lima Action Plan of five strategic action areas (UNESCO, 2017).

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