# REHABILITATION OF MANGROVES IN SABAH

The SFD-ISME Collaboration (2014–2019)



Sabah Forestry Department, International Society for Mangrove Ecosystems and Tokio Marine & Nichido Fire Insurance Co., Ltd.

## REHABILITATION OF MANGROVES IN SABAH The SFD-ISME Collaboration (2014–2019)

Joseph Tangah, Arthur Y.C. Chung, Sabah Forestry Department (SFD), Sandakan, Sabah, Malaysia

Shigeyuki Baba, Hung Tuck Chan & Mio Kezuka International Society for Mangrove Ecosystems (ISME), Okinawa, Japan



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Front Cover Photo: Mangrove vegetation at Sungai ISME in April 2019, with some species of fauna shown as insets.

Back Cover Photo: Staff members of Tokio Marine & Nichido Fire Insurance Co., Ltd., ISME and SFD planted mangroves at Pulau ISME on 28 August 2019.

Inside Cover Photos: Project boat escorting visitors at Sungai Weston.

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## About the Authors

#### Joseph TANGAH



Dr Tangah obtained his PhD from Universiti Malaysia Sabah (UMS). He is currently a Senior Research Officer (SRO) at the Forest Research Centre (FRC) of the Sabah Forestry Department (SFD), specialising in mangrove ecology, conservation and restoration. Since 2011, he has been the Project Leader (PL) of Phase One (2011–2014) and Phase Two (2014–2019) of the SFD-ISME Collaborative Project on Rehabilitation of Mangroves in Sabah. It is envisaged that he will continue as the PL of Phase Three (2019–2024).

### Arthur Y.C. CHUNG \_\_\_\_\_



Dr Chung obtained his DPhil from Oxford University, UK. He is currently the Deputy Head (Research & Publication) of the FRC, SFD. His field of expertise is in insect diversity and conservation, as well as forest insect pests. He is a research collaborator of the SFD-ISME and SFD-TBRC Projects, and an active researcher of the Heart of Borneo (HoB) Project and the Ramsar Site in Sabah. He is also a Research Fellow with the Institute of Tropical Biology & Conservation, UMS.

#### Shigeyuki BABA



Prof Baba obtained his PhD from the University of Kyushu in Japan. He served as the Deputy Executive Secretary and Executive Secretary of ISME since its establishment in 1990. Currently, the Executive Director of ISME (from 2011), he has coordinated all the projects by ISME. Since his retirement from University of the Ryukyus in 2013, he continues his untiring efforts in implementing on-going projects and in seeking funds for future projects of the society. In recognition of ISME's successful mangrove rehabilitation project, he was bestowed the Kiribati Order of Merit by the President of Kiribati in 2015.

### Hung Tuck CHAN \_



Dr Chan obtained his PhD from the University of Aberdeen in Scotland. A former Director of the Forest Research Institute Malaysia (FRIM), he served as the Vice-President of ISME and as the Executive Treasurer of ISME. He was awarded the Kesatria Mangku Negara (KMN) Medal from the Yang Dipertuan Agong in 1996, and appointed Project Coordinator of the ITTO-ISME Pre-Project 134/07 Rev. 1 (F) and Small Project 564/09 Rev. 1 (F). Currently, he is the Editor-in-Chief of ISME-GLOMIS E-Journal and Producer of ISME Newsletter.

#### Mio KEZUKA



Ms Kezuka obtained her MSc (Marine Biosciences) from Tokyo University of Marine Science and Technology in Japan. Currently, a Researcher at ISME, she coordinates projects in Kiribati and Malaysia. Talented in arts, she is in charge of layout designs of ISME publications. She is also involved in designing the Tropical Coastal Ecosystems Portal (TroCEP) of the National Institute of Environmental Studies (NIES), Tsukuba, Japan.

## Foreword

The SFD-ISME Project on Mangrove Rehabilitation in Sabah is a collaboration between the Sabah Forestry Department (SFD) and the International Society for Mangrove Ecosystems (ISME). Initiated in 2011, Phase One (2011–2014) was successfully completed with more than 150 ha of mangroves rehabilitated, with the launching of the International Exchange Program on Coastal Resources, a collaboration between SFD and the Tropical Biosphere Research Center (TBRC) of University of the Ryukyus in Okinawa, Japan, and with the publication of *Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration (2011–2014)*. We are grateful to Tokio Marine & Nichido Fire Insurance Co., Ltd. for the financial support of the project.

Phase Two led to the publication of *Rehabilitation* of Mangroves in Sabah: The SFD-ISME Project (2014-2019). Published by SFD, ISME and Tokio Marine & Nichido Fire Insurance Co., Ltd., the second book provides a synopsis of mangroves in Sabah, and an overview of Phase One of the SFD-ISME project in the Introduction. Other sections include Strategic Approaches adopted by the Project Steering Committee (PSC), and Case Studies at Sungai Tokio Marine (Kunak), Sungai TBRC (Lahad Datu), Ex-OP FELDA (Kalabakan) and Pulau ISME (Beaufort). The book also highlights Achievements accompanied by a Calendar of Activities. A chapter on Research and Findings is a new addition to the book. The printing of this book is timed to include the visit of Sabah by staff of Tokio Marine & Nichido Fire Insurance Co., Ltd. from 26–29 August 2019.

I take great pride in announcing that this SFD-ISME Mangrove Rehabilitation Project in Sabah is the longest collaboration in Malaysia with an international mangrove organization. Confirmation that Tokio Marine & Nichido Fire Insurance Co., Ltd. will be funding the project from 2019–2024 is great news for all of us involved in the project.



#### DATUK MASHOR MOHD JAINI

A spectacular double sunset at the Weston Wetlands in Beaufor

Chief Conservator of Forests, Sabah Forestry Department, Sandakan, Sabah, Malaysia.

## Message

With fond memories, I could still recall my two trips to Sabah. I attended the Eighth General Assembly (GA) of ISME in September 2011, and the ISME-ITTO Mangrove Educational Book Launch and Seminar in March 2013, held in Sandakan. Of significance was my appointment as the President of ISME during the Eighth GA in 2011. The events were held following the launching of the SFD-ISME Project on Mangrove Rehabilitation in Sabah. ISME is most grateful to the Sabah Forestry Department (SFD) for graciously hosting both events.

This book *Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration (2014–2019)* is a sequel to

Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration (2011–2014). The close cooperation between SFD and ISME is the key to the successful implementation and completion of Phase One and Phase Two. Datuk Sam Mannan, the Director of Forestry and Datuk Mashor Mohd Jaini, the Chief Conservator of Forests have given full support to the project via the Project Steering Committee, Project Leader and Mangrove Task Force. ISME led by Prof Shigeyuki Baba, the Executive Director, is most grateful to Tokio Marine & Nichido Fire Insurance Co., Ltd. for the financial support of the project from 2011–2014 for Phase One, 2014–2019 for Phase Two and 2019–2024 for Phase Three.



#### **PROF SANIT AKSORNKOAE**

President, International Society for Mangrove Ecosystems, Nishihara, Okinawa, Japan. Chairman, National Economics and Social Development Council of Thailand.





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The authors are thankful to Datuk Mashor Mohd Jaini, Chief Conservator of Forests, and Prof Sanit Aksornkoae, President of ISME, for their continuous support of the Collaborative Project on Mangrove Rehabilitation in Sabah. Senior management staff of SFD who have contributed significantly to the project included Datuk Sam Mannan, Director of Forestry, Mr Fidelis Edwin Bajau, Deputy Director (Development) and Mr Werfred Jilimin, Head of Enforcement, Investigation Division. Funds provided by Tokio Marine & Nichido Fire Insurance Co., Ltd. for the project are much appreciated.

Our gratitude goes to Dr Mami Kainuma and Ms Nozomi Oshiro for editing and proof-reading the book. Photographs by Assoc Prof Shin Watanabe, Assoc Prof Tohru Naruse, Dr Mami Kainuma, Mr Dauni Seligi and Ms Norimi Kimura are acknowledged with gratitude. We are grateful to Ms Marrynah Matami, the Assistant Wetland Manager of Borneo Sulaman Cove Sdn. Bhd. (BSC), Sulaman Wetlands in Tuaran, for organizing the field visit and mangrove planting for the students and teachers from Japan in March 2019, and for Tokio Marine & Nichido Fire Insurance Co., Ltd. in August 2019. The efforts by Mr Mohd Jumri Abd Hamid (GIS Section, FRC) for producing mangrove forest and project site maps used in this book are acknowledged. The successful implementation and completion of Phase One (2011–2014) and Phase Two (2014–2019) of the project were largely due to the close working relationship between SFD and ISME.



## Malay Names

Bakau	Mangrove	Pantai	Beach
Berhad	Limited	Pisau	Knife
Insurans	Insurance	Pulau	Island
Jambatan	Bridge	Sungai	River
Kampung	Village	Tanjung	Promontory
Kota	Town	Tapak Semaian	Nursery
Kuala	Estuary	Teluk	Bay
Laut	Sea	Yang Dipertuan Agong	King

## Abbreviations

asl	above sea level
Assoc	Associate
Asst	Assistant
BSC	Borneo Sulaman Cove Sdn. Bhd.
С	Carbon
CCF	Chief Conservator of Forests
СМ	Chief Minister
cm	centimeter
Co.	Company
COMB	Center of Molecular Biosciences
dbh	diameter at breast height
DFO	District Forestry Officer
DPhil	Doctor of Philosophy (Oxford)
Dr	Doctor
Ext.	Extension
FELDA	Federal Land Development Authority
FR	Forest Reserve
FRC	Forest Research Centre
FRIM	Forest Research Institute Malaysia
GA	General Assembly
GIS	Geographical Information System
ha	hectare
HoB	Heart of Borneo
HQ	Headquarters
HRH	Her Royal Highness
ISME	International Society for Mangrove Ecosystems
ITTO	International Tropical Timber Organization
KK	Kota Kinabalu
KMN	Kesatria Mangku Negara
Ltd.	Limited

LTER	Long-Term Ecological Research
m	meter
MoU	Memorandum of Understanding
MSc	Master of Science
MTF	Mangrove Task Force
NIES	National Institute of Environmental Studies
No.	Number
Nr	Near
OP	Occupational Permit
PhD	Doctor of Philosophy
PL	Project Leader
Prof	Professor
PSC	Project Steering Committee
RDC	Rainforest Discovery Centre
REDD	Reducing Emissions from Deforestation
	and Forest Degradation
SDGs	Sustainable Development Goals
SFD	Sabah Forestry Department
SMK	Sekolah Menengah Kebangsaan
	(National Secondary School)
sp.	species (singular)
spp.	species (plural)
SRO	Senior Research Officer
TBRC	Tropical Biosphere Research Center,
	University of the Ryukyus, Okinawa, Japan
TMNF	Tokio Marine & Nichido Fire Insurance Co., Ltd.
TroCEP	Tropical Coastal Ecosystems Portal
UK	United Kingdom
UMS	Universiti Malaysia Sabah
VJR	Virgin Jungle Reserve

## GLOSSARY

Acid sulphate soil: Formed under waterlogged conditions, these soils contain iron sulphides that form sulphuric acid when exposed.

**Anthesis**: Stage of flowers when the stamens have dehisced and the stigma are receptive.

**Beating-up**: A forestry term that refers to the replanting in forest areas where mortality is unduly high due to factors such as pests, strong winds, currents, etc.

**Breaching**: Making a gap or break through a bund, wall or barrier.

**Carapace**: The exo-skeleton (shell) covering the dorsal part (back) of a crab.

**Channel bed and slope**: The bottom and slope of dugout channels for drainage.

**Cluster planting**: Planting seedlings, propagules or cuttings in groups to establish intermittent plant populations as possible seed sources to regenerate degraded areas.

Cove: A small bay or coastal inlet.

**Drone**: An aircraft that does not have a pilot (unmanned aerial vehicle) but is controlled by someone on the ground, used especially for surveillance of a place.

**Forest reserves**: Sabah has seven classes of forest reserves. They are protection forests (Class I), commercial forests (Class II), domestic forests (Class III), amenity forests (Class IV), mangrove forests (Class V), virgin jungle reserves (Class VI) and wildlife reserves (Class VII).

**Gregarious**: Large numbers of a species growing in a single site.

**Group planting**: Planting of 2–3 propagules of *Rhizophora* species per group.

**Hybrid**: A cross between two related species, e.g., *Sonneratia* x *hainanensis*, a cross between *S. alba* (maternal parent) and *S. ovata* (paternal parent).

**Hypocotyl**: The elongated part of the propagule between the plumule and the radicle as in *Rhizophora* species.

**Mangrove zones**: A forest belt dominated by certain mangrove plant species.

**Natural regeneration**: The recruitment of seedlings and saplings by natural reproductive processes.

**Planting materials**: Propagules, seeds, seedlings and cuttings used for planting.

**Pneumatophores**: Aerial roots (pencil- or peg-like), which protrude vertically from under-ground horizontal roots.

**Precocious:** A behaviour in plants that displays early flowering and fruiting. *Rhizophora mucronata* starts to flower and fruit at 3-4 years of age while *Rhizophora apiculata* only starts at 6-7 years.

**Propagules**: Seeds, fruits or other plant parts, which when dispersed are able to produce new plants.

**Reeds**: Grass-like plants of the family Poaceae found in estuarine saltmarshes.

**Rehabilitation**: The act of restoring degraded mangroves back to its original condition.

Saplings: Seedlings that are more than a meter in height.

**Shoal**: A shoal is an islet formed at the river mouth due to deposition of sediments. It is exposed during the low tide and submerged during the high tide.

**Silviculture**: The art and science of planting, growing and tending of trees.

**Stilt or prop roots**: Roots growing from the lower part of the stem, bifurcating before entering the soil.

**Strategic approaches**: Ensuring success in planning and implementation, strategic approaches include collaboration and partnership, technology, policy change and development, capacity building, and systemic change and integration.

**Suluk**: The Suluk communities in Sabah are Muslims from Mindanao, Sulu and Palawan of the Philippines. They are holders of a special pass visa, which allows them to stay and find work in Sabah.

## INTRODUCTION

#### Mangroves of Sabah

Mangroves in Sabah occur mainly along the northeast, east and southeast coast where the towns of Sandakan, Lahad Datu and Tawau are located, respectively. Based on analysis of the latest satellite image interpretation, the total area of Class V mangrove forest reserves (FR) in Sabah is ~232,000 ha. These coastal plant communities in Sabah cover a larger area than any other state in Malaysia. Currently, the state has 16 mangrove FR, the largest being the Kuala Bonggaya and Kuala Labuk FR (43,253 ha) in Beluran and Sandakan. Other sizeable mangrove forests are the Trusan Kinabatangan FR (31,407 ha) in Kinabatangan; the Sungai Sugut, Paitan and Pulau Jambongan FR (38,708 ha) in Pitas and Beluran; and the Tawau FR (25,036 ha) in Tawau. Over in the southwest coast, the Menumbok FR covering 1,843 ha is the mangrove forest reserve (Class V) in Beaufort.



1 = Menumbok FR, 2 = Sungai Sugut, Paitan & Pulau Jambongan FR, 3 = Kuala Bonggaya & Kuala Labuk FR, 4 = Elopura FR, 5 = Trusan Kinabatangan FR, 6 = Kuala Segama & Kuala Maruap FR, 7 = Lahad Datu FR, and 8 = Tawau FR.

Map of Sabah showing the location of major mangrove forest reserves (Class V) and townships.

Mangrove Forest Reserve	Forestry District	Area (ha)	Total Area (ha)
Abai FR	Kota Belud		1,396
Bengkoka Peninsula FR	Kota Marudu & Pitas		13,283
Elopura FR	Sandakan	24,607	24,685
Ext.		78	
Kuala Bonggaya & Kuala Labuk FR	Beluran & Sandakan	43,217	43,253
Ext.		36	
Kuala Tingkayu FR	Kunak		3,822
Kudat FR	Kudat		7,065
Lahad Datu FR	Lahad Datu	9,705	9,754
Ext.		49	
Menumbok FR	Beaufort		1,843
Pulau Malawali FR	Kudat		791
Semporna FR	Semporna		22,911
Sibyte FR	Sandakan		2,364
Sulaman Lake FR	Kota Kinabalu		2,635
Sungai Gum-Gum & Sungai Loboh FR	Sandakan		3,086
Sungai Sugut, Sungai Paitan & P. Jambongan FR	Pitas & Beluran	38,564	38,708
Ext.		144	
Tawau FR	Tawau & Kalabakan		25,036
Trusan Kinabatangan FR	Kinabatangan		31,407
Total			232,039

Mangrove Forest Reserves (Class V) in Sabah (Lohuji & Tangah, 2019).

Ext. = Extension, FR = Forest Reserve.

In addition to the 16 mangrove FR (Class V) of 232,000 ha in Sabah, mangroves are also found in forest reserves designated as 108,900 ha of Protection Forests (Class I), 8,900 ha of Amenity Forests (Class IV), 9,500 ha of Virgin Jungle Reserves (Class VI) and 4,800 ha of Wildlife Reserves (Class VII). The total area of mangrove forests (All Classes) in Sabah is therefore 364,100 ha.

Examples of mangrove Virgin Jungle Reserves (VJR) are the Sungai Gologob VJR (~8,100 ha) in Kinabatangan

and the Sepilok (Mangrove) VJR (~1,200 ha) in Sandakan. Some mangroves are also found in Amenity Forests (Class IV) e.g. those along the banks of Sungai Garama and Sungai Klias in the Padas Damit FR (7,900 ha) in Beaufort. The largest Protection Forest (Class I) are the Kuala Segama & Kuala Maruap FR (24,200 ha) in Lahad Datu. The Menumbok FR (14,700 ha) together with the Weston FR (660 ha) in Beaufort are the other protection forests. In addition, there are also privatelyowned mangrove forests, e.g. the Labuk Bay Proboscis Monkey Sanctuary (260 ha).



& VII) angah, 2019).	1

	Class I		
Protection Forest	Forestry District	Area (ha)	Total Area (ha)
Kuala Bonggaya & Kuala Labuk FR	Beluran & Sandakan		13,188
Kuala Segama & Kuala Maruap FR	Lahad Datu	23,993	24,166
Ext.		173	
Marudu Bay FR	Kota Marudu		6,915
Menumbok FR	Beaufort	3,867	14,745
Ext.		10,878	
Pulau Bangi & Pulau Balambangan FR	Kudat		11,504
Sitompok FR	Beaufort		586
Sugut Wildlife Corridor FR	Beluran	300	368
Ext.		68	
Sungai Lasun & Pulau Evans FR	Lahad Datu		3,357
Sungai Maruap FR	Kinabatangan		6,789
Sungai Segama FR	Lahad Datu		600
Tawau FR	Tawau		13,158
Trusan Kinabatangan FR	Kinabatangan	9,064	12,898
Ext.		3,834	
Weston FR	Beaufort	293	659
Ext.		366	
Total			108,933
	Class IV		
Amenity Forest	Forestry District	Area (ha)	Total Area (ha)
Kampung Hindian FR	Beaufort		496
Nabahan FR	Beaufort	356	485
Ext.		129	
Padas Damit FR	Beaufort	7,587	7,899
Ext.		312	
Total			8,880
	Class VI		
Virgin Jungle Reserve	Forestry District	Area (ha)	Total Area (ha)
Batumapun (Mangrove) VIR	Tawau		164

Other Forest Reserves (Classes I, IV, VI & VII) in Sabah with mangrove vegetation (Lohuji & Tangah, 2019)

Virgin Jungle Reserve	Forestry District	Area (ha)	Total Area (ha
Batumapun (Mangrove) VJR	Tawau		164
Sepilok (Mangrove) VJR*	Sandakan		1,235
Sungai Gologob VJR	Kinabatangan	7,900	8,106
Ext.		206	
Total			9,505

\*Also known as Sepilok Laut.

	Class VII		
Wildlife Reserve	Forestry District	Area (ha)	Total Area (ha)
Balat Damit FR Ext.	Kinabatangan	4,140 670	4,810
Total			4,810

Currently, Sabah has two Ramsar sites. The Lower Kinabatangan-Segama Wetlands (78,800 ha) was designated in 2008. The Kota Kinabalu Wetland Centre (24 ha), the other Ramsar site, was established in 2016. These protected wetlands of international significance contain mangroves as the major forest type. Efforts are now being made to designate the Klias FR Class I (3,630 ha) as the third Ramsar site. Submission by the State Government was in 2017 for negotiation with Ramsar authorities. Approval usually takes 3–5 years.

Mangroves in Sabah can be classified into various forest types, dominated by one or two tree species. They are found in the seaward zone (*Avicennia-Sonneratia* forests), main mangrove zone (*Rhizophora* forests), back mangrove zone (*Bruguiera* forests) and riparian fringes (*Nypa* forests). The flora consists of trees, shrubs, woody climbers, palms, ferns and herbs. The fauna includes vertebrates (fish, amphibians, reptiles, mammals and birds), and invertebrates (insects and crustaceans).





Avicennia-Sonneratia forests comprising mainly of Avicennia alba and Sonneratia alba. Characterized by their extensive rooting systems of pneumatophores, these tree species represent the early colonisers of the accreting seaward zone of mangroves.



*Rhizophora apiculata* is one of the most common mangrove trees in Sabah. Occurring in the main mangrove zone, the species is characterized by prominent prop or stilt roots, floral buds in pairs and fine black spots at the under-surface of leaves.



Occurring at the landward zone, *Bruguiera* forests represent the back mangroves with *Bruguiera parviflora* being the dominant tree species. In open sites, thickets of *Acrostichum aureum* ferns are common undergrowth.



*Nypa* forests occur along the upstream banks of rivers where there is greater freshwater influence. *Nypa fruticans*, the mangrove palm, grows gregariously, interspersed with mud lobster mounds.



(L-R) Propagules of Bruguiera gymnorhiza and Bruguiera cylindrica, and fruits of Sonneratia caseolaris.



Propagules of Rhizophora mucronata (left) and fronds of Acrostichum aureum ferns (right).



Flowers (left) and fruits (right) of Scyphiphora hydrophylacea.

Although there are still vast areas of mangrove forests in Sabah, they come under increasing pressures for socio-economic development such as conversion to aquaculture, agriculture and urban land uses. Based on the latest assessment of forest cover of Sabah, about 3,300 ha of mangrove forests have been illegally encroached and exploited. Out of these, ~2,400 ha are in FR.



Illegal conversion of mangrove forests to oil palm plantations remains the most extensive encroachment activity of mangrove forests in Sabah.





Illegal smuggling of mangrove bark (left) and illegal conversion of mangrove forests to shrimp ponds (above) are the other encroachment activities.





Coastal erosion (left) and human settlements (above) are the other issues confronting the management of mangrove forests in Sabah.

INTRODUCTION



Other constraints of mangrove forest management are mortality of vegetation due to sedimentation.

#### The SFD-ISME Project

In July 2010, a delegation from the International Society for Mangrove Ecosystems (ISME) headed by Prof Shigeyuki Baba (Executive Director) accompanied by Dr Hung Tuck Chan (Executive Treasurer) and Ms Nozomi Oshiro (Head of Secretariat) visited the Sabah Forestry Department (SFD) in Sandakan to discuss on the feasibility of implementing a collaborative mangrove rehabilitation project in Sabah. The visit was a great success and led to the signing of Memorandum of Understanding (MoU) between the two organizations on 10 November 2010 in Kota Kinabalu. The occasion was witnessed by Mr Hironari Iwakuma, Director of Tokio Marine Insurans (Malaysia) Berhad.

In 2011, the SFD-ISME Collaborative Project on Rehabilitation of Mangroves in Sabah was initiated. Funded by Tokio Marine & Nichido Fire Insurance Co., Ltd. for three years (2011–2014), the mangrove rehabilitation project was implemented by SFD with technical guidance from ISME. Both organizations have collaborated well to ensure the successful implementation and completion of Phase One project activities (2011–2014).



Signing of first MoU between SFD and ISME.



Speech by Prof Shigeyuki Baba (left) and the SFD-ISME MoU ceremony was witnessed by Mr Hironari Iwakuma (right).

#### Sabah Forestry Depertment (SFD)

The vision of SFD since 1997 is towards the realization of sustainable forest management and conservation of the natural environment. Its noble mission is to effectively and efficiently plan and implement the management of forest resources in accordance with the principles of biodiversity conservation and sustainable forest management in Sabah. Various forest formations occur extending from coastal mangroves at sea level (asl) up to inland sub-alpine vegetation on Mt. Kinabalu at 4,100 m asl. Sabah has ~364,100 ha of mangrove forests under reservation, accounting for 58% of the country's total (Sarawak and Peninsular Malaysia have 23% and 19%, respectively) and 7.6% of the global total. Mangroves are an important natural resource to the state and are legally protected under the Sabah Forest Enactment (1968) *via* the establishment of forest reserves.

#### International Society for Mangrove Ecosystems (ISME)

ISME is an international non-profit and non-governmental scientific society established in August 1990. With its headquarters in Okinawa, Japan, ISME was certified a Foundation in 1992 by the Japanese Law of Foundation. In 2003, under a new Japanese law of promoting specified non-profit activities, ISME was registered as a non-profit organization. Revised at the Eighth General Assembly (GA) in 2012, the Statutes of ISME stipulate that 'the Society shall collect, evaluate and disseminate information on mangrove ecosystems', and 'shall promote international cooperation'.

ISME has been carrying out its activities at the global level through: a) application of knowledge to particular situations, b) training and education, and c) exchange of necessary information. Activities of the society have been supported through collaborations, and links with other organizations, universities, research institutes and local communities. Currently, the membership of ISME includes 44 institutions and nearly 1,200 individuals from 94 countries.



#### Tokio Marine & Nichido Fire Insurance Co., Ltd. (TMNF)

TMNF, with its headquarters in Tokyo, Japan, has been implementing mangrove planting projects since 1999. Having declared its intention to continue mangrove planting for 100 years in 2007, the company has projects in Bangladesh, Fiji, India, Indonesia, Malaysia, Myanmar, the Philippines, Thailand and Viet Nam. The projects in Malaysia (Sabah) and India (Gujarat) are being implemented by ISME. Each year, company staff, agents and their family members participate in a planting mangrove volunteer tour in a selected country. This year, a team of 41 staff members planted mangroves at Tuaran and Weston, Sabah, in August 2019. In addition, TMNF published *Mangrove-based Value Co-Creation 100-Year Declaration* with its aspiration to continue creating social values in collaboration with various stakeholders in October 2019. TMNF considers these mangrove planting activities as 'Insurance for the Future of the Earth.'

This collaboration presents a great opportunity for SFD to strengthen its capacity in mangrove rehabilitation. The department is honoured as Sabah is the first state in Malaysia to have such collaboration with an international agency such as ISME. The success of this project may attract other collaborative projects between institutions in Japan and Malaysia in the near future. Main objectives of the collaborative project are to meet an annual target of planting 50 ha of degraded mangroves in Sabah and to develop cost-effective methods for mangrove rehabilitation with the available funds from ISME. The project identifies areas for planting and adopts silvicultural techniques that will encourage sufficient vegetation cover for subsequent natural regeneration and recovery. Planting areas are located within forest reserves, which come under the jurisdiction of SFD.

Phase One (2011–2014) of the project successfully planted ~150 ha of degraded mangroves forests in 14 project sites, located in five forest reserves of four forestry districts. They were:

- Sungai Lalasun (12 ha), Sungai Batang (5.5 ha), Samawang Mile 25 (3.0 ha), Tanjung Pisau 1 (3.0 ha), Tanjung Pisau 2 (1.5 ha), Sungai Loboh (0.5 ha) and Sungai ISME (2.0 ha) in Sungai Gum-Gum & Sungai Loboh FR and Sibyte FR in Sandakan
- Sungai Mattangar (22 ha) in Kuala Bonggaya & Kuala Labuk FR in Beluran
- Sungai Klias 1 (15 ha), Sungai Klias 2 (22 ha), Sungai Garama 1 (30 ha) and Sungai Garama 2 (30 ha) in Padas Damit FR in Beaufort
- Pangkalan Madai (2.5 ha) and Pangi Ujung (3.5 ha) in Kuala Tingkayu FR in Kunak

	Forestry district	Area (ha)	Planting material	Year planted	
	Sandakan	26.5	40,850	2011-2013	
	Beluran	22	26,800	2013	
-	Kunak	6	10,220	2013	
-	Beaufort	97	112,000	2012-2014	
	Total	151.5	189,870		

#### Summary of mangrove planting during Phase One (2011–2014)



Map showing the locations of 14 project sites of Phase One in Sabah.





Commemorative planting of mangroves by participants of the ISME Eighth General Assembly on 13 September 2011 (left), and the visit by the staff of Tokio Marine & Nichido Fire Insurance Co., Ltd. from 5–7 September 2012 (right).



The completion of Phase One (2011-2014) of the project culminated with the publication of a book *Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration (2011-2014)* in 2015. Earlier,

SFD published *Mangroves of Sabah: An Introduction to the Flora and Fauna* in 2010, and ISME-ITTO published an Educational Series of Mangrove Books in 2013.



*Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration (2011–2014)* (left) and *Mangroves of Sabah: An Introduction to the Flora and Fauna* (right).



ISME-ITTO published an Educational Series of Mangrove Books, namely, Continuing the Journey amongst Mangroves (left), Structure, Function and Management of Mangrove Ecosystems (middle), and Useful Products from Mangrove and other Coastal Plants (right).

#### About this Book

Phase Two (2014–2019) of the project was launched with signing of another MoU between SFD and ISME at the SFD Headquarters in Sandakan on 13 August 2014. The occasion was attended by staff of SFD and ISME, and witnessed by five university students accompanied by three high school teachers from Tokyo.

With funding from Tokio Marine & Nichido Fire Insurance Co., Ltd., Phase Two of the project successfully planted ~200 ha of degraded mangroves forests in eight project sites, located in eight forest reserves of seven forestry districts. They were:

- Sungai Lelingkong, Kuala Bonggaya & Kuala Labuk FR (1.7 ha) in Beluran, and Sungai Menangin, Lalasun, Sungai Gum-Gum & Sungai Loboh FR (8.0 ha) in Sandakan
- Sungai Koyah (2.0 ha) in Bengkoka Peninsula FR, Pitas
- Sungai Dampirit (6.3 ha) in Kudat FR, Kudat
- Sungai Tokio Marine (56 ha) in Kuala Tingkayu FR, Kunak
- Sungai TBRC Ryukyus (12 ha) in Lahad Datu FR, Lahad Datu
- Ex-OP FELDA (75 ha) in Tawau FR, Kalabakan
- Pulau ISME (39 ha) in Weston FR (Ext.), Beaufort

	Forestry district	Area (ha)	Planting material	Year planted	
	Sandakan	8.0	6,636	2015	
	Beluran	1.7	375	2016	
	Kunak	56	155,870	2014-2017	
	Kalabakan	75	32,235	2015-2017	
	Pitas	2.0	5,620	2015-2016	
_	Kudat	6.3	10,300	2016	
_	Lahad Datu	12	13,855	2016-2019	
_	Beaufort	39	29,372	2016-2019	
	Total	200	254,263		

#### Summary of mangrove planting during Phase Two (2014-2019)



Map showing the locations of eight project sites of Phase Two in Sabah.

## Strategic Approaches

#### Project Steering Committee

Since Phase One of the SFD-ISME Collaborative Project on Rehabilitation of Mangroves in Sabah (2011–2014), the Project Steering Committee (PSC) has been formed. Chaired by Datuk Sam Mannan (Director of Forestry, SFD) from April 2011 to July 2018, and by Datuk Mashor Mohd Jaini (Chief Conservator of Forests, SFD) since August 2018, and co-chaired by Prof Shigeyuki Baba (Executive Director of ISME), the committee meets twice a year (usually in March and August) to develop the work plan, to discuss the budget and to monitor the progress of the project in the various study sites. Site conditions, choice of species, planting techniques, growth, mortality, pests and diseases are important topics in the agenda of the PSC. During Phase One (2011–2014) and Phase Two (2014–2019) of the project, the PSC met eight and ten times, respectively. The present members of the PSC, together with previous members from SFD, are as follows:

#### Present Members of the PSC from SFD, ISME and TBRC

gust 2018)
Chief Conservator of Forests (Chairperson)
Deputy Chief Conservator of Forests (Operation)
Deputy Chief Conservator of Forests (Planning & Management)
Deputy Chief Conservator of Forests (Research & Development)
Senior Assistant Chief Conservator of Forests
Head of Corporate Communication & Innovation
Head of Forest Resource Management
Head of Sustainable Forest Management Division
Head of Finance & Budget Division
Head of Investigation, Enforcement & Prosecution
Deputy Head (Research & Publication), Forest Research Centre
Senior Research Officer, Forest Research Centre (Project Leader)
District Forestry Officer of Sandakan
District Forestry Officer of Kota Kinabalu
District Forestry Officer of Beluran
District Forestry Officer of Kinabatangan
District Forestry Officer of Beaufort
District Forestry Officer of Kudat
District Forestry Officer of Kunak
District Forestry Officer of Lahad Datu
District Forestry Officer of Kalabakan
Senior Planning Officer, Forest Sector Planning (Secretary)
cosystems (ISME)
Executive Director (Co-Chairperson)
Executive Treasurer
Honorary Chief Technical Advisor
Senior Scientist
Voluntary Senior Researcher
Voluntary Researcher
Researcher
Researcher
Researcher
Head of Secretariat

Present Members of the PSC from SFD, ISME and TBRC (continued)

Tropical Biosphere Research Center (TBRC)			
Assoc Prof Shin Watanabe	Scientist		
Assoc Prof Tohru Naruse	Scientist		

#### Previous Members of the PSC from SFD (April 2011 to July 2018)

Sabah Forestry Department (April 2011 to July 2018)				
Datuk Sam Mannan	Director of Forestry (Chairperson)			
Mr Fidelis Edwin Bajau	Deputy Director (Development)			
Mr Frederick Kugan	Deputy Director (Forest Sector Planning)			
Mr Albert Radin	Deputy Director (Forest Management Enterprise)			
Dr Ying Fah Lee	Deputy Director (Research & Development)			
Dr Joseph Tangah	Senior Research Officer and Project Leader			
Mr Werfred Jilimin	Head of Enforcement & Investigation Division			
Mr Mohd Salleh Hj Abbas	Senior Planning Officer			
Mr Fadzil Hj Yahya	District Forestry Officer (Sandakan)			
Mr George Angampun	District Forestry Officer (Beaufort)			
Mr Petin Kilou	District Forestry Officer (Beluran)			
Mr Jaime Gampawi	District Forestry Officer (Kunak)			
Mr Eddie Bungkoris	District Forestry Officer (Kalabakan)			
Mr Jurimin Ebin	District Forestry Officer (Lahad Datu)			
Ms Siti Zubaidah S. Abdullah	International Forestry & Corporate Affairs			

#### Project Leader

Dr Joseph Tangah (Senior Research Officer of FRC) has been appointed the Project Leader (PL) since Phase One (2011–2014) of the project. Due to his excellent performance, he continued as the PL for Phase Two (2014–2019) of the project. It is envisaged that he will continue as the PL for the next five years of Phase Three (2019–2024).

The role of Dr Joseph Tangah as the PL is crucial as he is responsible for all project activities. They include planting operations, monitoring, field studies, PSC meetings and visits. He draws up all the technical specifications when a planting operation requires a contractor. During each PSC meeting, he reports on the progress of the project (budget, planting operations, case studies, planned activities including constraints and achievements). At the end of each fiscal year, he submits reports on the progress of the project to ISME for revision, translation and submission to Tokio Marine & Nichido Fire Insurance Co., Ltd.



Dr Joseph Tangah, the Project Leader.



### ISME and SFD Secretariats

The ISME and SFD Secretariats headed by Ms Nozomi Oshiro in Okinawa, Japan, and Ms Siti Zubaidah S. Abdullah in Sandakan, Sabah, respectively, are key personnel of the project. They work very closely with the PL concerning PSC meetings (venues, letters of invitation and minutes), visits to Sabah and Japan (flights, accommodation and programs), finances (remittances and donations), etc.



Dr Joseph Tangah (Project Leader) with Ms Nozomi Oshiro of ISME Secretariat (left), and with Ms Siti Zubaidah S. Abdullah of SFD Secretariat (right).

#### Mangrove Task Force

As endorsed by the PSC since April 2011, SFD has established a Mangrove Task Force (MTF) for the project, led by Dr Joseph Tangah (PL). The current members are Mr Dauni Seligi, Mr Jamiss Aribin, Mr Fabian Koret and Mr Charlesvyne Francis. Guided by the PSC and scientists of ISME, the MTF is dedicated to all activities of the project. They include the choice of species, planting method for the different sites, collecting planting materials, monitoring growth and survival, identifying causes of mortality, and conducting initial planting trials. The MTF works very closely with the forestry staff in the districts where the project sites are located and with the contractors involved with the planting operations.

During PSC meetings along with field visits of projects, and visits by students and teachers, the MTF is fully committed to all aspects of the program activities. They include logistics such as transport, guidance, security, etc.



Dr Joseph Tangah, the Project Leader (middle) heads the Mangrove Task Force (MTF) comprising (L–R) Mr Charlesvyne Francis, Mr Fabian Koret, Mr Dauni Seligi and Mr Jamiss Aribin as members.

### Monitoring Projects in the Field

Coinciding with each PSC meeting, SFD and ISME staff members visit the project sites. Such field visits are essential to monitor the progress of planting operations, and to discuss on limitations and constraints. Suggestions of improvements can then be made to rectify some of the problems encountered.





Staff of ISME and SFD visited Sungai Tokio Marine, Kunak in August 2018.





Staff of ISME and SFD visited Ex-OP FELDA, Kalabakan in August 2018.



Accompanied by the PL and MTF, staff of ISME visited the new concrete signage at Sungai ISME in August 2018.

#### Strategic Approaches





Staff of ISME and SFD visited the new concrete bridge at Sungai ISME in March 2019.





Revisited Sungai Lalasun in March 2019.

#### SFD-TBRC Collaboration

As follow-up to the SFD-ISME Collaborative Project on Mangrove Rehabilitation in Sabah, the SFD-TBRC Collaborative Project on Research, Training and Capacity Building was started since 2014. Research activities included monitoring of the growth of planted mangrove in Sungai ISME (Sandakan) and Sungai Tokio Marine (Kunak), studying decapods in Sandakan and Lower-Kinabatangan Segama. Associate Prof Shin Watanabe and Associate Prof Tohru Naruse are the key scientists from the Iriomote Station of TBRC in Japan. Formed in 1994, TBRC of University of the Rukyus has another station at Sesoko. The Nishihara Station and the Center of Molecular Biosciences (COMB) are located in the campus of University of the Rukyus in Senbaru, Nishihara, Okinawa.



Assoc Prof Shin Watanabe (left, photo by N. Kimura) and Assoc Prof Tohru Naruse (right) are key TBRC scientists from Japan.

Under Phase Two (2014–2019) of the SFD-ISME collaborative project, four project sites were chosen for case studies. They are Sungai Tokio Marine in Kunak, Sungai TBRC Ryukyus in Lahad Datu, Ex-OP FELDA in Kalabakan and Sungai ISME in Beaufort.

#### Sungai Tokio Marine (Kunak)



At Sungai Tokio Marine (Desa Arca), an illegal shrimp farm comprising 13 ponds of 56 ha encroached into the Kuala Tingkayu FR (Class V). The culprits have since been prosecuted and the abandoned shrimp ponds have been selected as one of the key study sites for mangrove rehabilitation under Phase Two of the SFD-ISME collaborative project. Planting was conducted from 2014–2017. A total of ~156,000 propagules, seeds and seedlings of *Avicennia alba*, *Nypa fruticans*, *Rhizophora*  Location: Sungai Tokio Marine (Desa Arca) Forestry District: Kunak Forest Reserve: Kuala Tingkayu (Class V) Year of planting: 2014–2017 Area planted: 56 ha

Species planted	Planting material	Year planted
Avicennia alba	20 seedlings	2014
Nypa fruticans	10,000 seeds	2014
Rhizophora apiculata	94,700 propagules	2014-2016
Rhizophora mucronata	49,650 propagules	2014-2016
Terminalia catappa	1,500 seedlings	2014
Total	155,870	

*apiculata*, *Rhizophora mucronata* and *Terminalia catappa* were planted.

The early phases of planting in the abandoned shrimp ponds (2014–2015) were most challenging. High mortality rates were encountered due to acid sulphate soils and poor drainage. Planted *Rhizophora* propagules had their embedded parts darkened, and failed to root and establish. Planting became more successful after



Drone photo of Sungai Tokio Marine ponds taken by S. Watanabe in September 2017.

several years of tidal flushing by having more pond bunds breached to facilitate water inflow and outflow. Progressively, *Rhizophora mucronata* established well along the perimeter of ponds with higher ground elevation. Growth of *Rhizophora* in the lower sections of the pond substrate was less luxuriant and less dense. Planting of *Terminalia catappa* on the top of bunds was the most successful with some trees producing seedlings beneath them. Besides improving tidal flow and drainage, and reducing the problem of acid sulphate soils, the breaching of the bunds would encourage the inflow of water-borne propagules from the adjacent forest into the ponds.



An opened sluice gate and a bund breached to facilitate inflow and outflow of tidal water.



*Rhizophora mucronata* grew well along the perimeter of ponds with high ground elevation. Some plants started early production of flowers and propagules.



A pond with healthy stand of *Rhizophora* except for the blank in the top left corner (left) and another pond with grown up stand of *Rhizophora apiculata* (right).



A *Rhizophora* stand where the growth is less luxuriant and less dense (photo taken in March 2019). The substrate here is lower in elevation and drainage is incomplete during the low tide.





Trees and natural regeneration of *Terminalia catappa* displayed luxuriant growth.





During certain months, large numbers of migratory egrets can be seen foraging in the abandoned ponds. Other fauna found throughout the year are the edible *Telescopium* (gastropod) and *Polymesoda* (bivalve). These shellfish are collected by the local Suluk communities, Muslims originated from Mindanao, Sulu and Palawan of the Philippines.



Sungai TBRC Ryukyus (Lahad Datu)



Sungai TBRC Ryukyus, an encroachment by Suluk settlements into the Lahad Datu FR, is another study site for mangrove rehabilitation under Phase Two of the SFD-ISME collaborative project. Planting was conducted from 2016–2019 using a total of ~14,000 propagules, cuttings, seeds and seedlings. Species included Acanthus ebracteatus, Avicennia alba, Bruguiera parviflora, Calophyllum inophyllum, Ceriops tagal, Excoecaria agallocha, Talipariti tiliaceum, Rhizophora apiculata, Rhizophora mucronata, Terminalia catappa and Xylocarpus granatum.

Grazing by goats remains the major problem of mortality of planted species, even after repeated planting operations. Belonging to Suluk villagers living nearby, Location: Sungai TBRC Ryukyus Forestry District: Lahad Datu Forest Reserve: Lahad Datu (Class V) Year of planting: 2016–2019 Area planted: 12 ha

Species planted	Planting material	Year planted
Acanthus ebracteatus	30 cuttings	2018
Avicennia alba	30 seedlings	2016
Bruguiera parviflora	15 seedlings	2016
Calophyllum	210 seedlings	2019
inophyllum		
Ceriops tagal	150 seedlings	2016
Excoecaria agallocha	550 seedlings	2016-2019
Talipariti tiliaceum°	100 cuttings	2019
Rhizophora apiculata	10,000 propagules	2016-2017
Rhizophora mucronata	2,500 propagules	2016-2017
Terminalia catappa	200 seedlings	2016-2018
Xylocarpus granatum	50 seedlings	2018
Total	13,835	

<sup>°</sup>New name for *Hibiscus tiliaceus*.

herds of goats would encroach into the area soon after planting to feed on the shoots of plants.

With limited success, strategies adopted by the Mangrove Task Force were circular-clearing of weeds around fast-growing plant species such as *Terminalia catappa* in more elevated ground, and cluster planting of mangroves species such as *Rhizophora apiculata* in low-lying sites that are inundated during the high tide. It appears that the goats avoid trotting into moist sites with saline water. The use of fences against the goats may not work due to theft by the Suluk villagers. Some form of negotiation with the villagers is therefore necessary to overcome the grazing problem by goats.



Grazing by goats remains the greatest challenge to mangrove planting in Sungai TBRC Ryukyus.



Clusters of planted *Rhizophora apiculata* seedlings grown on low-lying sites, escaped grazing by goats in Sungai TBRC Ryukyus (photo taken in March 2019).

### Ex-OP FELDA (Kalabakan)



An area of the Ex-Occupational Permit (OP) of the Federal Land Development Authority (FELDA) in Kalabakan (75 ha) was selected as the third study site of the Phase Two collaborative project. Propagules and seedlings of *Rhizophora apiculata*, *Rhizophora mucronata* and *Terminalia catappa* were planted in 2015 by a contractor, and seedlings of *Casuarina equisetifolia* were planted from 2016–2017 by members of the Mangrove Task Force (MTF).

In 2013, SFD terminated all OPs within the FELDA areas in Kalabakan due to lapse in annual payment in land use. The following year, all areas which have been planted with second rotation oil palm seedlings were removed. The legume *Mucuna bracteata* planted as cover crop started to growth out of control within three months. The creeper grew so rapidly engulfing all the species planted including the fast-growing *Terminalia catappa* and *Casuarina equisetifolia*. The growth of *Mucuna bracteata* was so aggressive that it invaded the adjacent mangrove vegetation forming a curtain over the trees.

Location: Ex-OP FELDA Forestry District: Kalabakan Forest Reserve: Tawau (Class V) Year of planting: 2015–2017 Area planted: 75 ha

Species planted	Planting material	Year planted
Casuarina equisetifolia	100 seedlings	2016-2017
Rhizophora apiculata	16,800 propagules/ seedlings	2015
Rhizophora mucronata	4,000 propagules	2015
Terminalia catappa	11,335 seedlings	2015
Total	32,235	

As the use of chemical herbicides for eradication of *Mucuna bracteata* was not allowed, the MTF members conducted bi-monthly mechanical clearing operation using grass-cutters with very sharp steel blades. Treatment included regular beating-up (replanting) and weeding of surviving plants.



A *Terminalia catappa* plant that is vulnerable to be engulfed by *Mucuna bracteata* creepers.



Regular weeding of Mucuna bracteata was conducted, adopting both mechanical (left) and manual (right) methods.



One success story of *Terminalia catappa* after a hard fought battle.

### Pulau ISME (Beaufort)



Location: Pulau ISME, Sungai Weston Forestry District: Beaufort Name of Forest Reserve: Weston (Ext.) Class I Year of planting: 2017–2019 Area planted: 39 ha

Species planted	Planting material	Year planted
Avicennia alba	3,200 seedlings	2017-2019
Ceriops tagal	172 seedlings	2019
Rhizophora apiculata	25,500 propagules	2017-2019
Rhizophora mucronata	500 propagules	2017
Total	29,372	

Located at the estuary of Sungai Weston in Beaufort, Pulau ISME is an islet or shoal named after ISME in honour of the society's contribution towards mangrove rehabilitation in Sabah. Covering 39 ha, Pulau ISME has been selected as the fourth study site of the Phase Two collaborative project. Exposed during the low tide and submerged during the high tide, the early plant colonizers of the Pulau ISME are reeds (Poaceae) that form fields at the outer edge of the islet. Reeds of the family Poaceae are grass-like plants of estuarine saltmarshes. They help to trap and stabilize the sediments and over time, the reed fields are gradually replaced by *Sonneratia caseolaris* trees (5–8 m tall) through succession. Groves of rapidly-growing *Sonneratia caseolaris* with dense natural regeneration of seedlings and saplings dominate the interior part of the islet.

Rehabilitation of Pulau ISME started in 2016 and 2017 using propagules of *Rhizophora apiculata* and *Rhizophora mucronata*, respectively. Subsequently, seedlings of *Avicennia alba* and *Ceriops tagal* were planted from 2017–2019. A total of almost 30,000 planting materials were used. Planting of mangroves has to be done during the low tide and occasional strong currents require the group method of planting.



Map showing Pulau ISME at the estuary of Sungai Weston in Beaufort.



Pulau ISME is an islet or shoal formed at the mouth of Sungai Weston due to deposition of muddy sediments.





Reeds are the early colonizers forming fields in the outer edge of the islet. Yet to be encountered by the MTF team, these habitats are likely resting and nesting sites for the Estuarine Crocodile.



Planting of mangroves has to be done during the low tide (left), trees of *Sonneratia caseolaris* with dense seedlings and saplings dominate the interior part of the islet (right top), and occasional strong currents require the group method of planting (right bottom).



Fauna such as proboscis monkeys (left top, photo by M. Kainuma) and egrets (left bottom) are commonly seen at Sungai Weston, and the wetland sunset here is enchantingly beautiful (right).

## Research and Findings

#### Plant Diversity and Ecology

#### • Plants (Watanabe & Tangah, 2015; Tangah et al., 2016)

An assessment of plants was conducted in Sungai ISME (2 ha) four years after planting. Results of the inventory revealed the presence of 16 mangroves species belonging to six families, and another 36 coastal species belonging to 21 families. Of these, species planted were *Avicennia alba*, *Bruguiera cylindrica*, *Ceriops tagal*, *Rhizophora apiculata*, *Rhizophora mucronata* and *Terminalia catappa*.



Propagules of *Rhizophora mucronata* (left) and fruits of *Xylocarpus granatum* (right).

Within Sungai ISME, two individuals of *Sonneratia* x *hainanensis*, a natural hybrid of *Sonneratia alba* (maternal parent) and *Sonneratia ovata* (paternal parent), were encountered. Trees of *Sonneratia alba* occur within the project site while several individuals of *Sonneratia ovata* were observed along the river of Sungai ISME, bordering the eastern boundary of the project site (Kainuma *et al.*, 2017).



Flowers of *Sonneratia alba* after anthesis (top) and buds of *Sonneratia* x *hainanensis* (bottom).

Planted and wild mangrove plant species found at the planting sites of Sungai ISME in 2016.

No.	Mangrove plant species	No.	Mangrove plant species
1	Avicennia alba*	11	Nypa fruticans
2	Acrostichum aureum	12	Rhizophora
3	Bruguiera parviflora		apiculata*
4	Bruguiera cylindrica*	13	Rhizophora
5	Bruguiera sexangula		mucronata*
6	Ceriops tagal*	14	Sonneratia alba
7	Ceriops zippeliana	15	Sonneratia x
8	Excoecaria agallocha		hainanensis°
9	Lumnitzera littorea	16	Xylocarpus
10	Lumnitzera racemosa		granatum

\*Mangrove species planted in 2011, °A hybrid of *Sonneratia alba* and *Sonneratia ovata*.

## Other coastal plant species found at the planting site of Sungai ISME in 2016.

No.	Coastal plant species	No.	Coastal plant species
1	Acacia mangium	19	Imperata confertum
2	Allophylus cobbe	20	Lygodium microphyllum
3	Benincasa hispida	21	Melastoma malabathricum
4	Calamus erinaceus	22	Microsorum sclopendria
5	Carex indica	23	Morinda citrifolia
6	Chloris barbata	24	Nephrolepis biserrata
7	Cyperus diffusus	25	Oxyceros longiflora
8	Dalbergia candenatensis	26	Passiflora foetida
9	Derris trifoliata	27	Pluchea indica
10	Eclipta enecta	28	Phyllanthus urinaria
11	Eupatorium odoratum	29	Pongamia pinnata
12	Flagellaria indica	30	Sida rhombifolia
13	Ficus microcarpa	31	Sida elliptica
14	Glochidion littorale	32	Sporobolus indicus
15	Heritiera littoralis	33	Stenochlaena palustris
16	<i>Hyptis</i> sp.	34	Talipariti tiliaceum $^\circ$
17	Ischaemum magnum	35	Terminalia catappa*
18	Ischaemum muticum	36	Vitex pinnata

<sup>°</sup>New name for *Hibiscus tiliaceus*, \*The only coastal species planted.



1 = Sungai ISME, the river; 2 = concrete wall signage, completed in March 2018; 3 = concrete bridge, completed in October 2018.

A drone photograph of Sungai ISME taken by S. Watanabe in September 2017. The project site (2 ha) was encroached by the oil palm plantation in 2011.

![](_page_40_Picture_4.jpeg)

The encroached project site at Sungai ISME before planting in 2011 (left), Sungai ISME is a river that borders the eastern boundary of the planting site (right).

![](_page_41_Picture_1.jpeg)

A survey on major species planted in Sungai ISME was conducted in 2015 by mapping their locations and measuring their heights in relation to their ground level and flooding frequency. From the results, it is possible to determine the ecological niches of each species by interpreting their site preferences and physiological tolerance.

This study on the ecological niches of different mangrove tree species based on tree heights (cm), ground level (cm) and flooding frequency (%) was conducted in 2015. Highlights of the research findings are:

• The tallest trees in the study site are those of *Avicennia alba* followed by *Terminalia catappa*. Their heights were up to 4 m and 3 m, respectively. *Avicennia alba* is suitable for planting in the intertidal zone while *Terminalia catappa* grows well on top of the bunds above the tidal zone where the soils have hardened due to exposure to the sun. Being a fast-growing species, *Terminalia catappa* grows rapidly with good crown and bole diameter growth. In terms of natural regeneration, the species is a good choice, as the trees start early production of seedlings on the forest floor.

• Ranging from 0.5–1.0 m in height, trees of *Ceriops tagal* are niche specific, confining to ground level of 100 cm and flooding frequency of 3%.

• Among the two *Rhizophora* species, *Rhizophora* mucronata (1.0–2.0 m tall) strive in lower ground levels (0–50 cm) that are more frequently flooded (18–50%). On the contrary, *Rhizophora apiculata* (0.5–2.0 m tall) are more tolerant to a wider ground level range (0–150 cm) and flooding frequency (0–50%).

• Planted *Rhizophora mucronata* and *Rhizophora apiculata* displayed precocious or early production of flowers and propagules at 3-4 years and at 6-7 years, respectively.

![](_page_41_Figure_9.jpeg)

## Correlation between Tree Height & Ground Level

Scatter-gram by S. Watanabe showing ground level (cm) and flooding frequency (%) vs. tree height (cm) of species at Sungai ISME.

![](_page_42_Picture_1.jpeg)

Avicennia alba, Terminalia catappa and Ceriops tagal at Sungai ISME in April 2019.

Propagules of *Rhizophora apiculata* and *Rhizophora mucronata* are the best choices of planting materials in Sungai ISME. Suitable habitats for planting *Rhizophora apiculata* and *Rhizophora mucronata* are the intertidal beds (bottom) and slopes of channels, and for planting *Terminalia catappa* are the supra-tidal tops of bunds.

Overall, the survival rate of planted mangrove in Sungai ISME is above 80% and replanting is not necessary. Species with outstanding growth rates are *Terminalia catappa*, *Avicennia alba*, *Rhizophora mucronata* and *Rhizophora apiculata*.

![](_page_42_Picture_5.jpeg)

Signboard of Sungai ISME.

![](_page_42_Picture_7.jpeg)

![](_page_42_Picture_8.jpeg)

Rhizophora apiculata and Rhizophora mucronata at Sungai ISME in April 2019.

![](_page_43_Picture_1.jpeg)

### Fauna Diversity and Ecology

#### • Insects (Chung & Tangah, 2015, 2017; Chung et al., 2018)

Insects are often used as bio-indicators to indicate the effects of habitat changes and fragmentation, and the effectiveness of management schemes. Insect diversity has been used as a tool to indicate the status of the area surveyed, and to compare with other forested sites in Sabah. Under the SFD-ISME and SFD-TBRC collaborative projects, insect diversity has been used as a tool to monitor status of Sungai ISME planted with mangrove trees in 2012. Nocturnal insect diversity monitored through light-trapping has been conducted since 2015. Insect diversity indices as well as species richness and abundance were used to monitor the environmental status of the site.

In general, there is an improvement from the perspective of insect fauna. When compared with other forested sites, however, the insect diversity in Sungai ISME is still relatively low. Besides nocturnal insects, diurnal insects sampled using sweep nets and forceps were also documented. The insect data serve as baseline information for future research work on mangrove rehabilitation as well as to strengthen the ongoing collaborative research among the relevant agencies on tropical mangrove ecosystems. The insect data procured from surveys in 2015–2017, serve as baseline information for this area. It can be used to evaluate the status of biodiversity in this mangrove rehabilitation area for the subsequent years. Through biodiversity documentation, key conservation target species could be highlighted for planning and formulation of conservation plans, and also for monitoring purposes in order to safeguard the integrity and well-being of the area. Highlighted here are some of the insects found in Sungai ISME. Butterflies, moths, beetles and dragonflies are among the major groups documented.

![](_page_43_Picture_7.jpeg)

Daytime sampling using sweep net at the Sungai ISME.

#### Butterflies (Lepidoptera)

Large and interesting butterflies recorded from Sungai ISME included *Idea leuconoe nigriana* (Mangrove Tree Nymph), *Parantica agleoides borneensis* (Dark Glassy Tiger) and *Papilio polytes theseus* (Common Mormon). *Idea leuconoe nigriana* is a polka-dot butterfly, slow and graceful in flight, and it is a distinctive species of the mangrove environment. *Papilio agleoides borneensis* is another common species of the back mangrove habitats where the larvae feed on the foliage of the climber, *Tylophora flexuosa*. It is easily recognized through its brown

with white lines and dots on its wings. *Papilio polytes theseus* is a dark-coloured swallow-tailed butterfly with a series of white spots decreasing in size towards the apex on the upper forewing. The larvae have been reported feeding on the leaves of the Mangrove Lime, *Merope angulata*, locally known as Limau Buaya. This butterfly is not only confined to mangrove swamps

but also found in various other habitats. A small lycaenid butterfly, *Rapala pheretima pheretima*, is the only endemic sub-species recorded from Sungai ISME. It is known as Copper Flash because of its dark brown colour. The species is common throughout Asia but this sub-species is only confined to Borneo. Other common nymphalid butterflies which were sighted during the survey include *Junonia atlites, Junonia orithya* and *Hypolimnas bolina*. Common lycaenid butterflies, *Hypolycaena erylus teatus* and *Arhopala pseudocentaurus*, were sighted feeding on the nectar of some flowering shrubs within the site.

![](_page_43_Picture_13.jpeg)

#### Moths (Lepidoptera)

More than 30 moth species were recorded from Sungai ISME site. Five hawk moth species were documented. A few hawk moth species are pollinators while some of the hawk moth caterpillars are defoliators. A moth, Trabala krishna, and a wasp-like moth, Amata huebneri were among the few interesting moths documented from Sungai ISME site. The moth, Trabala krishna is known to be commonly found in mangrove habitats. From the insect surveys in Sungai ISME, the dayflying moth, Amata huebneri, was sighted visiting the flowers of Terminalia catappa. Many others are lesserknown micro-moths of the family Crambidae, such as Omiodes diemenalis and Dichocrocis nr. frenatalis. The former has been recorded feeding on Derris a common mangrove climber, while the latter genus is known to be a dominant mangrove insect in Guangxi Province of China.

#### Beetles (Coleoptera)

Among the macro-beetles documented in Sungai ISME, Oryctes rhinoceros (Rhinoceros Beetle) is the largest beetle. This is a pest in oil palm plantation and its presence was mainly due to the adjacent oil palm habitat. Other beetles sighted during the light-trapping include Glycyphana festiva (Flower Beetle) and Lycostomus sp. (Net-winged Beetle). G. festiva was also found visiting the flowers of Terminalia catappa during daytime. Other common beetles encountered included the Leaf Chafers, Anomala pallida and Adoretus compressus.

#### Dragonflies and damselflies (Odonata)

Dragonflies that were sighted during the surveys are from the family Libellulidae, and a damselfly, Argiocnemis rubescens, from the family Coenagrionidae. Thus far, those recorded from Sungai ISME are common species. Both Neurothemis ramburii and N. terminata are common deep-red dragonflies in the lowlands. Similarly, Orthetrum testaceum, Orthetrum glaucum and Orthetrum sabina are also frequently encountered in similar habitats. Rhyothemis phyllis is a sun-loving, bee-like dragonfly that is often seen fluttering fairly high above the open areas. Dragonflies and damselflies are ecologically important in the mangroves as predators of mosquitoes and midges.

#### Other insects

Other insects recorded during the surveys are from the order Hymenoptera, Hemiptera, Mantodea, Neuroptera, Orthoptera and Diptera. Oecophylla smaragdina (Common Weaver Ant) is almost everywhere in Sungai ISME. It is found nesting and foraging on trees of T. catappa. At night, a few species of flying Camponotus ants were attracted to the light trap. Some sap-sucking bugs and a few cicada species were recorded. Praying mantises were also sighted but they were not able to be identified as they were still at the nymphal stage. Chrysopa, Hybris and Myrmeleon are among the neuropterans recorded. As a group, they are commonly known as lacewings and antlions. Other common insects such as Valanga nigricornis (Yellow Locust), Mecopoda sp. (Bush Cricket) are often found in the open and grassy habitats.

![](_page_44_Picture_9.jpeg)

Anomala pallida (beetle)

Neurothemis terminata (dragonfly)

![](_page_45_Picture_1.jpeg)

#### • Ichthyfauna (Manjaji-Matsumoto et al., 2016)

Sungai ISME was selected as the study site to assess fish diversity of a rehabilitated mangrove forest under the SFD-ISME collaboration project. Monitoring the diversity of fish species was carried out in 2016 with the primary objective of documenting and assessing fish biodiversity in a newly rehabilitated mangrove landscape. The results will determine the effects of mangrove restoration on fish diversity and will provide some baseline data for Sungai ISME. The study reported a total of 37 fish species belonging to 24 genera, 14 families and six orders (N = 118). This included seven species identified up to the family level, one species (Giant Mudskipper, Periophthalmodon schlosseri) which was observed but no specimen obtained, and one grouper species caught downstream of Sungai ISME by a local fisherman. The most speciose family was Gobiidae (nine species, including four unidentified species), while eight families were represented by only one species. Gobiidae (gobies and mudskippers) and Leiognathidae (ponyfishes) are the two top families with the most number of individuals per species caught (N = 10; 8.5%each of the total number).

The notably interesting priapiumfish *Neostethus* sp. (family Phallostethidae) is a new record for the northeast coast of Borneo. Members of the family are small and slender (known maximum size not exceeding 40 mm TL), transparent to opaque, and thus are easily missed or mistaken for fish larvae. The males have a pair of bilaterally asymmetric spiny thoracic structure termed the priapium, an intromittent organ for internal fertilization. Although the family is ubiquitous throughout the brackish waters of Southeast Asia, two new species were only described in the last two years, both from this region. Two other species are thought to be endemic to Borneo.

Results of this study indicate that the diversity is relatively high (37 species), although the catch abundance is low (N = 118). The low catch abundance is partly attributed to sampling efficiency, and that with increased efforts (sampling time), the species record might be increased. Although mangrove plants have displayed luxuriant growth in Sungai ISME, the ichthyofaunal community seems to have only partially recovered from the recent disturbance of the estuarine habitat, and from continued fishing pressure at present time. Nevertheless, the presence of large juvenile fish assemblages is a good indicator that the rehabilitated mangrove ecosystem is in the process of restoring to a high level of habitability. For a mangrove ecosystem to serve as a nursery, its complex structure is vital for increasing the chances of juvenile survivorship. The benefits of a complex root system of the mangrove forest ecosystem, is manifested in the accumulated muddy substrates, and turbidity which provides juveniles the ideal environment to forage food, and to escape from their natural predators.

![](_page_45_Picture_6.jpeg)

![](_page_45_Picture_7.jpeg)

Using the cast net to catch fish from Sungai ISME.

#### • Mammals, Birds and Herpetofauna (Tangah et al., 2015)

Among the mammals observed directly were *Callosciurus* notatus (Plantain Squirrel), *Macaca fascicularis* (Longtailed Macaque), *Trachypithecus cristatus* (Silvered Langur). The presence of *Sus barbatus* (Bearded Pig) was detected by signs and tracking.

![](_page_46_Picture_3.jpeg)

Among the herpatofauna at Sungai ISME identified via direct observations or interview were Boiga dendrophila (Mangrove Snake), Crocodylus porosus (Estuarine Crocodile), Ophiophangus hannah (King Cobra), Python reticulatus (Reticulated Python) and Varanus salvator (Water Monitor Lizard). In April 2019, a night survey of Sungai ISME was conducted and an interesting species of frog was encountered. It was identified as Fejervarya cancrivora, or commonly known as the nocturnal Asian brackish frog or crab-eating frog. Birds identified in Sungai ISME via direct observations

No.	Species (Common Name)
1	Anhinga melanogaster (Oriental Darter)
2	Actitis hypoleucos (Common Sandpiper)
3	Aplonis panayensis (Asian Glossy Starling)
4	Caprimulgus macrurus (Large-tailed Nightjar)
5	Centropus sinensis (Greater Coucal)
6	Chalcophaps indica (Emerald Dove)
7	<i>Egretta garzetta</i> (Little Egret)
8	Geopelia striata (Zebra Dove)
9	Halcyon chloris (Chestnut-collared Kingfisher)
10	Ictinaetus malayensis (Black Eagle)
11	Ixobrychus sinensis (Yellow Bittern)
12	Lonchura atricapilla (Chestnut Munia)
13	Lonchura fuscans (Dusky Munia)
14	Merops viridis (Blue-throated Bee-eater)
15	Orthotomus ruficeps (Red-headed Tailorbird)
16	Passer montanus (Eurasian Tree Sparrow)
17	Pycnonotus goiavier (Yellow-vented Bulbul)
18	Spilornis cheela (Crested Serpent Eagle)
19	Streptopelia chinensis (Spotted Dove)
20	Todiramphus chloris (Collared Kingfisher)
21	Pachycephala grissola (Mangrove Whistler)
22	Aegithina tiphia (Common Iora)
23	Dinopium javanense
	(Common Flameback Woodpecker)

![](_page_46_Picture_7.jpeg)

*Fejervarya cancrivora* camouflages itself by having a body coloration and patterning that blend with the muddy mangrove substrate.

![](_page_47_Picture_1.jpeg)

### New Genus and Species of Crab (Naruse et al., 2015)

Under the SFD-TBRC collaboration, field surveys of crustaceans were conducted at the Sepilok Laut Reception Centre (28 February to 3 March 2014) and at the Lower Kinabatangan-Segama Wetlands (16–21 June 2014). These activities were part of a research project on

the survey of brachyuran fauna in mangrove ecosystems around Sandakan and Lower Kinabatangan-Segama, Sabah.

A remarkable scientific achievement was the discovery of a new genus and species of crab *Exagorium fidelisi* Naruse, Chung & Tangah. *Exagorium*, the genus name, is in part derived from the hexagonal shape of the carapace. The species was named after Mr Fidelis Edwin Bajau, the former Deputy Director of Development, SFD. Belonging to the family Camptandriidae, the specimen was sampled from a creek adjacent to a *Nypa* forest in Lower Kinabatangan-Segama. This outstanding finding was published in the *Raffles Bulletin of Zoology*, 2015, 63, 327–333.

![](_page_47_Picture_7.jpeg)

*Exagorium fidelisi* (left, photo by T. Naruse), named after Mr Fidelis Edwin Bajau (right).

### Insect Pest of Sonneratia: A New Record (Tangah & Chung, 2017)

In February 2017, caterpillars were found defoliating young and mature *Sonneratia caseolaris* trees growing on Pulau ISME in Weston FR. The caterpillar is hairy, whitish brown in colour with dark brown patterns on the body and can grow up to 80 mm in length. The mature caterpillar pupated in a whitish silky cocoon and the moth that emerged was identified as *Streblote helpsi* Holloway (Lepidoptera: Lasiocampidae). The male moth has narrow brown variegated forewings, with a body length of 3 cm and a wing span of 4.5 cm. The female was larger with rounded forewings, body length of 4 cm and wing span of 6 cm. This moth species is endemic to Borneo and has been attacking the foliage of *Casuarina equisetifolia* and *Khaya senegalensis*. In Sungai Weston, *Sonneratia caseolaris* is a new host plant record of *Streblote helpsi*. In February 2019 (in the same month, two years later), another attack by *Streblote helpsi* was observed.

![](_page_47_Picture_12.jpeg)

Caterpillars of Streblote helpsi (left), a newly emerged male adult (middle), and a defoliated stand of Sonneratia caseolaris (right).

### Long-Term Ecological Research (Tangah et al., 2018)

Endorsed during the PSC Meeting in Sandakan on 20 March 2017, the long-term ecological research (LTER) plots were established in June and July 2017 at Sepilok Laut. Five permanent circular plots, 15 m in radius or 0.7 ha in area, were set-up linearly, 50–80 m apart and ~10 m along the boardwalk that connects the Reception Centre.

Within each plot, trees with diameters of 10 cm at breast height and above were measured with a diameter tape, mapped and identified to the species level. All trees were tagged with a numbered tag and marked with red paint. Their coordinates were recorded using a GPS gadget and their heights were measured with a hypsometer. The census included living and dead trees.

Results showed distinct species composition in relation to plot location in the different mangrove zones. Plot 1 (being the most seaward) is in the main mangrove zone while Plot 5 (being the most landward) is in the back mangrove zone. Plot 1 contained *Ceriops tagal* (36), *Rhizophora apiculata* (9), *Lumnitzera littorea* (8) and *Scyphiphora hydrophylacea* (1) not found in Plot 5 which contained *Syzygium leucoxylon* (13), *Heritiera littoralis* (9), *Pouteria obovata* (5) and *Diospyros ferrea* (1) not found in Plot 1. *Bruguiera sexangula*, found in both plots, was the only exception. Two species namely *Syzygium leucoxylon* and *Diospyros ferrea* were new records for Sepilok Laut.

A total of 11 species belonging to eight families and 10 genera were identified. Rhizophoraceae was the most dominant family in all plots. *Ceriops tagal* (44.5%) was the most abundant followed by *Rhizophora apiculata* (25.7%), *Lumnitzera littorea* (6.9%) and *Bruguiera sexangula* (6.9%). Species diversity per plot was  $4.6 \pm 1.1$  species and stem density was  $43.6 \pm 14.2$  individuals per plot. The tree canopy height ranged from 16–22 m tall and the mean carbon density in the LTER site was 159 t C/ha.

![](_page_48_Picture_7.jpeg)

Sepilok Laut showing the Reception Centre and LTER study site.

![](_page_48_Picture_9.jpeg)

Marking a tree with red paint before tagging.

![](_page_49_Picture_1.jpeg)

#### Publications and Reports

The following are publications and reports related to the SFD-ISME project on rehabilitation of mangroves in Sabah and to the SFD-TBRC collaboration:

Baba, S., Chan, H.T., Kainuma, M., Oshiro, N., Kezuka, M., Kimura, N. & Inoue, T., 2019. Adaptation to climate change through mangrove rehabilitation involving local community participation. *ISME/GLOMIS Electronic Journal*, 17(2), 4–14.

Chung, A.Y.C. & Tangah, J., 2015. Insect diversity of Sungai ISME, Sandakan, Sabah. Unpublished progress report of the Sabah Forestry Department. 20 pp.

Chung, A.Y.C. & Tangah, J., 2017. Showcasing some insects of Sungai ISME, Sandakan, Sabah. Power-point presentation of the Sabah Forestry Department. 26 pp.

Chung, A.Y.C., Tangah, J. & Japir R., 2018. Insect diversity as a tool to monitor the status of a rehabilitated mangrove site in Sabah. *Sepilok Bulletin*, 27, 30–50.

Kainuma, M., Colin, I., Baba, S., Chan, H.T., Tangah, J., Cohen, M., Whitkus, R. & Ong, J.E., 2017. Molecular identification of *Sonneratia ovata* and *S. x hainanensis* in Sabah, Malaysia. Poster presented at the *International Conference on Sustainable Mangrove Ecosystems*, 18–21 April 2017, Bali, Indonesia.

Lohuji, P.L. & Tangah, J., 2019. Brief notes on mangrove forest reserves in Sabah based on the Forest Enactment 1968. Unpublished Report of the Sabah Forestry Department, 5 pp.

Manjaji-Matsumoto, B.M., Yee, J.C., Watanabe, S. & Tangah, J., 2016. Ichthyofaunal diversity of a rehabilitated tropical mangrove forest reserve in Sabah. *Sepilok Bulletin*, 23 & 24, 15–35.

Naruse, T., 2015. Decapod crustaceans in the mangrove ecosystems around Sandakan and Lower Kinabatangan-Segama Wetlands, Sabah. Paper presented at *First Sabah's Ramsar Conference*, Kota Kinabalu, 12 November 2015.

Naruse, T., Chung, A.Y.C. & Tangah, J., 2015. Description of a new genus and a new species of the

family Camptandriidae Stimpson, 1858 (Crustacea: Decapoda: Brachyura) from Lower Kinabatangan-Segama Wetlands, Sabah, Malaysia. *Raffles Bulletin of Zoology*, 63, 327-333.

Tangah, J., 2013. Current status and research activities under the SFD-ISME mangrove rehabilitation project in Sabah. Paper presented at the SFD, ISME and TBRC Joint Seminar on Mangrove Management in Sabah and Biodiversity in Ryukyu Islands, 5 September 2013, Faculty of Agriculture, University of the Ryukyus, Okinawa, Japan.

Tangah, J., 2014. Rehabilitation of mangroves in Sabah – The SFD-ISME collaboration. Address delivered at the *Annual Meeting of the Japan Society for Mangroves*, 22 November 2014, Tokyo University of Agriculture, Tokyo, Japan.

Tangah, J., 2017. A decade of restoration efforts and rehabilitation of degraded mangroves in Sabah. *International Conference on a Decade of Heart of Borneo Initiative: Accomplishments and the Way Forward*, 24–25 October 2017, Magellan Sutera, Kota Kinabalu, Sabah.

Tangah, J., Baba, S. & Chan, H.T., 2012. Cluster planting of mangroves along Sungai Garama, Beaufort, Sabah, Malaysia. *ISME-GLOMIS Electronic Journal* 10(6), 16–18.

Tangah, J., Baba, S. & Chan, H.T., 2016. SFD & ISME collaboration on mangrove rehabilitation in sustainable forest management. Paper presented at the *Second Sabah's Ramsar Conference*, 10 November 2016, Kota Kinabalu, Sabah.

Tangah, J., Baba, S., Chan, H.T. & Chung, A.Y.C., 2013. Cluster planting trial at Sungai Garama, Beaufort, Sabah. Paper presented at the *National Seminar on Coastal Forest Conservation*, 11–12 June 2013, Universiti Malaysia Terengganu, Terengganu, Malaysia.

Tangah, J., Bajau, F.E., Baba, S., Chan, H.T., Oshiro, N., Jilimin, W., Kimura, N., Suara, Z., Lohuji, P.L. & Loisang, D., 2017. The SFD and ISME collaboration on rehabilitation of degraded mangroves in Sabah: A success story towards sustainable forest management. Paper presented at the *International Conference on Sustainable Mangrove Ecosystems*, 18–21 April 2017, Bali, Indonesia.

Tangah, J., Bajau, F.E., Jilimin, W., Baba, S., Chan, H.T. & Kezuka, M., 2015. *Rehabilitation of Mangroves in Sabah: The SFD-ISME Collaboration* (2011-2014). Sabah Forestry Department, International Society for Mangrove Ecosystems, and Tokio Marine & Nichido Fire Insurance Co., Ltd., 56 pp.

Tangah, J. & Chung, A.Y.C., 2017. A new record of *Streblote helpsi* (Lepidoptera, Lasiocampidae) defoliating *Sonneratia caseolaris*. *Sepilok Bulletin*, 25 & 26, 33–35.

Tangah, J., Nilus, R., Sugau, J.B., Titin, J., Paul, V., Yahya, F., Suis, M.A.F. & Chung, A.Y.C., 2018. A note on the mangrove long-term ecological research (LTER) in Sepilok Laut, Sabah. *Sepilok Bulletin*, 27, 1–22. Tangah, J., Seligi, D., Koret, F. & Aribin, J., 2015. A preliminary list of animals found at Sungai ISME in Sungai Gum-Gum and Sungai Loboh FR. Unpublished Report of the Sabah Forestry Department.

Tangah, J., Seligi, D., Koret, F. & Aribin, J., 2016. List of plants found at Sungai ISME in Sungai Gum-Gum and Sungai Loboh FR. Unpublished Report of the Sabah Forestry Department.

Watanabe, S. & Tangah, J., 2015. Preliminary survey to set-up a long-term mangrove monitoring site and to establish a transcriptome database for primary mangrove species in Sabah. Paper presented at *First Sabah's Ramsar Conference*, 12 November 2015, Kota Kinabalu, Sabah.

Watanabe, S., Uchiyama, S., Tangah, J., Toyohiko Miyagi, T. & Baba, S., 2017. Challenge to support mangrove rehabilitation by drone (unmanned aerial vehicle). Poster presented at the *International Conference on Sustainable Mangrove Ecosystems*, 18–21 April 2017, Bali, Indonesia.

## ACHIEVEMENTS

![](_page_51_Picture_1.jpeg)

The MoU of Phase One (2011–2014) and Second Phase (2014–2019) of SFD-ISME Project on Rehabilitation of Mangroves in Sabah was signed on 10 November 2010 and 13 August 2014, with planting targets of 150 ha and 200 ha, respectively. Annual targets were therefore 50 ha for Phase One and 40 ha for Phase Two. By the end of 2019, the project area totaled more than 350 ha of mangroves within 22 planting sites with more than 444,000 planting materials used. The planting targets

depended on the amount of funds agreed upon by Tokio Marine & Nichido Fire Insurance Co., Ltd., the main funding agency based in Tokyo, Japan.

Survival rate of mangroves planted ranged from 55–95% depending on site conditions. Replanting or beating up is no longer needed if survival rate achieved more than 80%. Most of the planting sites of Phase Two were concentrated on abandoned shrimp ponds (e.g. Sungai Tokio Marine in Kunak) and on illegal oil palm plantations within the mangrove forest reserves (e.g. Ex-OP FELDA in Kalabakan).

#### Funds and Facilities

Besides the funding from Tokio Marine & Nichido Fire Insurance Co., Ltd., SFD has raised additional funds for the project *via* a special fund or the recurrent budget at FRC. The printing cost of this book is borne by these funds. Two 4WD vehicles were dedicated for Phase One and another 4WD vehicle for Phase Two of the project. Under Phase Two, a motor boat has been refurbished for use in the field to transport planting materials. A new nursery was established at the FRC in Sepilok, Sandakan, replacing the old nursery at Sibyte.

A refurbished boat has been custom built for transportation of planting materials in the field during Phase Two.

![](_page_51_Picture_9.jpeg)

SFD has dedicated two 4WD vehicles for Phase One and another 4WD vehicle for Phase Two of the project.

![](_page_51_Picture_11.jpeg)

The new mangrove nursery at FRC showing the signboard (left) and potted seedlings of *Rhizophora apiculata* (right).

#### Training and Capacity Building

Training and capacity building are two thrust areas of the SFD-ISME and SFD-TBRC collaborative projects. Members of the MTF benefited by being trained in conducting forest surveys, field sampling of decapods, preparing voucher specimens in the herbarium, and

![](_page_52_Picture_3.jpeg)

identification of natural hybrids such as *Sonneratia* x *hainanensis*. A specialised training of grafting fruit trees was given by Mr Katsuhiko Sato. More importantly, the MTF members have developed self-acquired skills such as eradication of *Mucuna bracteata* using grass-cutters and piloting the boat while transporting planting materials in the field.

![](_page_52_Picture_5.jpeg)

The MTF members are trained in forest survey (left, photo by S. Watanabe), in field sampling of decapods (middle, photo by T. Naruse) and in monitoring diameter growth of trees (right).

![](_page_52_Picture_7.jpeg)

![](_page_52_Picture_8.jpeg)

The MTF members are trained in preparing voucher specimens in the herbarium (left) and in grafting of plants (right) (photos by M. Kainuma).

![](_page_52_Picture_10.jpeg)

![](_page_52_Picture_11.jpeg)

Grass-cutting (left) and piloting the boat (right) are skills acquired by the MTF members.

#### Incorporation of Research

One of the major achievements of Phase Two (2014–2019) of the project was the incorporation of research in addition to the efforts in meeting the annual targets in the rehabilitation of mangroves in Sabah. This present book has devoted a chapter on 'Research and Findings'.

The projects included the following:

- $\circ~$  Plant diversity and ecology in Sungai ISME
- Fauna diversity and ecology in Sungai ISME (insects, ichthyfauna, mammals, birds and herpetofauna)
- New genus and species of crabs
- New insect pest of Sonneratia caseolaris
- o Long-term ecological research in Sepilok Laut

![](_page_53_Picture_1.jpeg)

### Cooperation and Friendship

The success of Phase One (2011–2014) of the project was largely due to the spirit of cooperation and friendship between SFD and ISME, which continued to strengthen into Phase Two (2014–2019). The relationship started in September 2007, when a delegation of government officials from Sabah led by SFD visited the mangroves of Okinawa, Ishigaki and Iriomote Islands in Japan. ISME hosted the visit and since then, mutual friendship has established between SFD and ISME officials.

During Phase One and Phase Two of the project, a PSC Meeting was held in Okinawa, Japan in September 2013 and in July 2015, respectively. These PSC Meetings in Japan enabled members from SFD to visit the research expertise and experience the culture in Japan. Likewise, the visits by school and university students, and by school teachers from Japan during the PSC Meetings in Sabah have provided useful nature education and sociocultural experience.

Besides visiting activities of the SFD-ISME project, field excursions to places of interest in and around Kota Kinabalu included the KK Wetland Centre, Weston FR, Sungai Klias, Rafflesia Centre, Mount KK Park and Lok Kawi Wildlife Park. Over in Sandakan, trips were organized to visit the Rainforest Discovery Centre (RDC), Orang Utan Rehabilitation Centre and Bornean Sun Bear Conservation Centre in Sepilok, Mangrove Discovery Centre in Sepilok and the Proboscis Monkey Sanctuary at Labuk Bay.

![](_page_53_Picture_7.jpeg)

The cooperation and friendship between SFD, ISME and TBRC have always been courteous and respectful.

![](_page_53_Picture_9.jpeg)

SFD-ISME friendship is like wine (left), it gets better as it grows older (right, photo by M. Kainuma).

Achievements

![](_page_54_Picture_1.jpeg)

Drone display after the PSC Meeting in the University of the Ryukyus, Okinawa, Japan.

![](_page_54_Picture_3.jpeg)

The SFD delegation enjoying their Japanese cuisine during a lunch hosted by ISME.

![](_page_54_Picture_5.jpeg)

Visits by students and teachers from Japan, and planting mangroves in the field are important activities of the SFD-ISME project.

Achievements

![](_page_55_Picture_1.jpeg)

Such visits are often accompanied by a modest donation to SFD as goodwill.

### The Way Forward

Tokio Marine & Nichido Fire Insurance Co., Ltd., the funding agency, has approved funding to cover Phase Three (2019–2024) of the project. The planting target will be 35 ha/year or a total of 175 ha for five years.

- 150 ha in the seaward mangrove shore of Semporna FR in Semporna have been identified for future planting program under Phase Three of the SFD-ISME project.
- The waterlogged habitats (80 ha) at Borneo Sulaman Cove (BSC) of the Sulaman Wetlands at Tuaran are another rehabilitation site.

![](_page_55_Picture_7.jpeg)

The Sulaman mangroves at the Borneo Sulaman Cove (BSC).

![](_page_55_Picture_9.jpeg)

The seaward mangrove shore at Semporna FR in Semporna.

## CALENDAR OF ACTIVITIES

![](_page_57_Picture_1.jpeg)

![](_page_58_Picture_0.jpeg)

#### February 2015

The Ninth PSC Meeting was held on 3 February 2015 in the Belian Room, SFD Headquarters in Sandakan, Sabah, and chaired by Datuk Sam Mannan, the Director of Forestry.

![](_page_58_Picture_4.jpeg)

After the Ninth PSC Meeting, participants from SFD and ISME congratulated each for the completion of the SFD-ISME book on the project from 2011–2014.

#### July 2015 \_

Chaired by Prof Shigeyuki Baba, the Tenth PSC Meeting was held on 21 July 2015 in the Fiftieth Anniversary Memorial Hall, University of the Ryukyus, Okinawa, Japan. The 14-member delegation from SFD was headed by Mr Fidelis Edwin Bajau.

- 1. Mr Fidelis Edwin Bajau
- 2. Mr Frederick Kugan
- 3. Mr Albert Radin
- 4. Mr Werfred Jilimin
- 5. Dr Arthur Y.C. Chung
- 6. Dr Joseph Tangah
- 7. Mr Zulkifli Suara
- 8. Mr Donatus Loisang
- 9. Mr Peter Jack
- 10. Mr Paul Leo Lohuji
- 11. Mr Jaime Gampawi
- 12. Mr Petin Kilou
- 13. Mr Adrian Rawlenes
- 14. Ms Siti Zubaidah S. Abdullah

![](_page_58_Picture_22.jpeg)

The Tenth PSC Meeting in the Fiftieth Anniversary Memorial Hall, University of the Ryukyus, Okinawa, Japan.

Before the PSC meeting, the delegation from SFD paid a courtesy call on Prof Hajime Oshiro, the President of University of the Ryukyus. Some publications in the form of books were presented as souvenirs to the President during the occasion.

> The delegation from SFD with the President at his office in University of the Ryukyus, Okinawa, Japan.

![](_page_58_Picture_26.jpeg)

#### CALENDAR OF ACTIVITIES

![](_page_59_Picture_1.jpeg)

After the PSC meeting, members had an opportunity to witness a drone demonstration conducted by Assoc Prof Shin Watanabe in front of the Memorial Hall. The white, four-pronged and helicopter-like drone is cheaper and easier to manoeuvre compared to the more conventional drone. It can fly vertically up to 2,000 m above the ground, and takes good photographs for monitoring and research purposes.

![](_page_59_Picture_3.jpeg)

The drone at close up (left) and in flight (right)

While in Okinawa, the delegation visited the Ryukyu Mura Cultural Village, Churaumi Aquarium and Tropical Dream Centre at the Ocean Expo Park at Motobu. Local transportation was by means of a chartered blue bus. They then proceeded to Tokyo and visited the office of Tokio Marine & Nichido Fire Insurance Co., Ltd., and other destinations of cultural significance.

![](_page_59_Picture_6.jpeg)

The iconic whale shark at the Churaumi Aquarium (left) and the picturesque greenhouse at the Tropical Dream Centre (right).

![](_page_59_Picture_8.jpeg)

The SFD delegation at Tokio Marine & Nichido Fire Insurance Co., Ltd. at Chiyoda-ku in Tokyo, Japan.

#### August 2015

Accompanied by Prof Shigeyuki Baba, five students from Chiba University of Japan visited Sandakan, Sabah from 25–29 August 2015. On 26 August 2015, the students paid a courtesy call on Datuk Sam Mannan, Director of Forestry and donated RM3,200 to the department for mangrove rehabilitation activities in Sabah. While in Sabah, the students planted mangroves at Kunak and Beluran together with a few local university students who were on internship at the Forest Research Centre (FRC) in Sepilok. The students from Japan came on their own expenses to show their commitment towards mangrove rehabilitation by planting.

![](_page_60_Picture_3.jpeg)

Students from Chiba University, Japan, and from Universiti Malaysia Sabah (UMS) in Beluran.

![](_page_60_Picture_5.jpeg)

Students from Chiba University, Japan, and from Universiti Malaysia Sabah (UMS) in Kunak.

#### November 2015 \_\_\_\_

The International Conference on the Heart of Borneo (HoB): Bridging HoB Landscapes and Beyond through Healthy Watershed Corridors was held from 11–12 November 2015, in Magellan Sutera Harbour Resort, Kota Kinabalu, Sabah. During the keynote session of the HoB Conference, Prof Shigeyuki Baba from the International Society for Mangrove Ecosystems (ISME) delivered a keynote on *Current status of mangroves worldwide: the vital corridor linking the sea and inland forests.* His ancient Okinawan proverb 'No forest on the land, no fish in the sea' was in the headline of Sunday Daily Express (a local newspaper), the next morning.

On 12 November 2015, the First Sabah's Ramsar Conference 2015 was concurrently held in the same venue. Assoc Prof Shin Watanabe and Assoc Prof Tohru Naruse, both from TBRC of University of the Ryukyus, presented their research findings entitled

![](_page_60_Picture_10.jpeg)

Prof Shigeyuki Baba delivering his keynote address at the HoB Conference.

Preliminary survey to set-up a long-term mangrove monitoring site and to establish a transcriptome database for primary mangrove species in Sabah and Decapod crustaceans in the mangrove ecosystems around Sandakan and the Lower Kinabatangan-Segama Wetlands, Sabah, respectively.

![](_page_61_Picture_1.jpeg)

In the afternoon of 12 November 2015, delegates from ISME (Prof Shigeyuki Baba and Dr Hung Tuck Chan) and from TBRC (Assoc Prof Shin Watanabe and Assoc Prof Tohru Naruse) visited the former Honourable Chief Minister (CM) of Sabah

at his Sri Gaya residence in Kota Kinabalu. They were accompanied by Mr Fidelis Edwin Bajau and Dr Joseph Tangah from SFD. During the occasion, ISME presented the former CM with a piece of bingata fabric.

![](_page_61_Picture_4.jpeg)

Morning session of the First Ramsar Conference in Kota Kinabalu, Sabah.

### April 2016 –

The Eleventh PSC Meeting was held on 12 April 2016 in the Auditorium, SFD Headquarters in Sandakan and chaired by Datuk Sam Mannan, Director of Forestry.

![](_page_61_Picture_8.jpeg)

Participants during the Eleventh PSC Meeting (left) and group photo after the meeting (right).

### June 2016 -

The International Conference on Climate Change, Biodiversity and Ecosystem Services for Sustainable Development Goals (SDGs): Policy and Practice was held from 27–29 June 2016 at the Sirindhorn International Environmental Park in Cha-am, Phetchaburi Province, Thailand. The opening ceremony of the conference was graciously presided by Her Royal Highness Princess Maha Chakri Sirindhorn in celebration of her 5th Cycle Birthday Anniversary. At the invitation of Prof Sanit Aksornkoae (Member of the National Legislative Assembly of Thailand and President of ISME), a delegation from ISME comprising Prof Shigeyuki Baba, Dr Hung Tuck Chan, Dr Tomomi Inoue and Ms Nozomi Oshiro attended the conference.

![](_page_61_Picture_12.jpeg)

Prof Sanit Aksornkoae welcoming HRH Princess Maha Chakri Sirindhorn. © icccb.sirindhornpark.or.th.

![](_page_62_Picture_1.jpeg)

Prof Shigeyuki Baba (left) and Dr Hung Tuck Chan (right) receiving an award from HRH Princess Maha Chakri Sirindhorn. © icccb.sirindhornpark.or.th.

ISME presented a paper entitled Adaptation to climate change through mangrove rehabilitation involving local community participation. Recently published in the ISME/GLOMIS Electronic Journal in 2019, the paper described three on-going mangrove projects with comparisons made based on performance indicators and the involvement of community participation. The projects were the mangrove rehabilitation project in Tarawa, Kiribati; the mangrove plantation project in Gujarat, India; and the project on rehabilitation of mangroves in Sabah, Malaysia. Based on 10 criteria, the project in Sabah scored 25 for overall performance (high for accessibility, collaboration, objectives, publicity, capacity building, voluntary participation and sustainability). In comparison, the projects in Tarawa and Gujarat were comparable with overall scores of 20 and 19, respectively.

![](_page_62_Picture_4.jpeg)

Tarawa, Kiribati.

![](_page_62_Picture_6.jpeg)

Gujarat, India.

Evaluation Criteria	Tarawa, Kiribati	Gujarat, India	Sabah, Malaysia
Accessibility	+	++	+++
Collaboration	++	++	+++
Objectives	+++	+++	+++
Costs	++	+++	+
Publicity	++	+	+++
Capacity Building	++	+	+++
Voluntary Participation	++	+	+++
Community Participation	++	+++	+
Conservation Awareness	++	++	++
Sustainability	++	+	+++
Overall Performance	20	19	25

#### Evaluation of the performance of three ISME mangrove rehabilitation projects

Symbols: + weak, ++ moderate and +++ strong. High project cost is given a low score. There is a correlation between capacity building and project sustainability. Poor community participation as in Sabah did not adversely affect overall performance.

![](_page_63_Picture_1.jpeg)

#### August 2016 -

The Twelfth PSC Meeting was held in the Belian Room, SFD Headquarters in Sandakan on 25 August 2016 and chaired by Datuk Sam Mannan, Director of Forestry. Five university students, from different universities throughout Tokyo, together with four other high school teachers from Tokyo, attended the meeting as observers. They generously donated RM3,000 in support of the project activities. After the meeting, the students and teachers had the opportunity to go on a field trip together with several university students from Sabah to plant mangroves in the shrimp ponds of Sungai Tokio Marine in Kunak District.

![](_page_63_Picture_4.jpeg)

University students and school teachers from Tokyo at the Rafflesia Centre in Tambunan.

![](_page_63_Picture_6.jpeg)

University students and school teachers from Tokyo with Universiti Malaysia Sabah (UMS) students at Sungai Tokio Marine, enjoying their refreshing drink of coconut water.

#### November 2016 -

The Second Sabah's Ramsar Conference with the theme, 'Wetlands for our Future: Sustainable Livelihood' was held in the Magellan Sutera Harbour Resort, Kota Kinabalu, Sabah on 10 November 2016. Papers related to this project included:

Ong, J.E., 2016. A mangrove-centric view of wetlands for future sustainable use in Malaysia.

Tangah, J., *et al.*, 2016. SFD & ISME collaboration on mangrove rehabilitation in sustainable forest management.

## March 2017 \_\_\_\_\_

The Thirteenth PSC Meeting was held on 20 March 2017 in the Belian Room, SFD Headquarters in Sandakan and chaired by Datuk Sam Mannan, Director of Forestry.

#### April 2017

The International Conference on Sustainable Mangrove Ecosystems held in Denpasar, Bali, Indonesia from 18–21 April 2017 was organised by ITTO, ISME and the Ministry of Forestry, Indonesia.

Prof Sanit Aksornkoae delivered his welcome remarks as the President of ISME. The delegation from ISME was represented by Prof Shigeyuki Baba, Dr Jin Eong Ong, Dr Hung Tuck Chan, Dr Mami Kainuma and Ms Karin Baba. Also present were Dr Tomomi Inoue, National Institute for Environmental Studies (NIES), Japan; Assoc Prof Shin Watanabe, TBRC, University of the Ryukyus, Okinawa, Japan; and Dr Bharatkumar Jethva, ISME Mangrove Plantation Project, Gujarat, India. SFD was represented by Mr Fidelis Edwin Bajau, Dr Joseph Tangah, Mr Werfred Jilimin, Mr Zulkifli Suara, Mr Paul Leo Lohuji and Mr Donatus Loisang.

![](_page_64_Picture_4.jpeg)

Welcome remarks by Prof Sanit Aksornkoae, the President of ISME (left), and oral presentation of papers by Dr Tomomi Inoue (middle) and Dr Joseph Tangah (right) © www.itto.int/mangrove2017.

![](_page_64_Picture_6.jpeg)

The ISME delegation at the Bali Conference.

Papers presented by ISME, SFD, TBRC and NIES at the Bali Conference in April 2017 were:

- Tangah, J., *et al.* 2017. The SFD and ISME collaboration on rehabilitation of degraded mangroves in Sabah: A success story towards sustainable forest management.
- Inoue, T., 2017. Carbon storage of mangrove ecosystems: Global maps of reported data and estimated models.
- Ong, J.E., 2017. Measuring mangrove REDD and blue carbon fluxes.
- Jethva, B., 2017. Mangrove plantations for manifold benefits: A case study in Gujarat, India.
- Kainuma, M., et al., 2017. Molecular identification of Sonneratia ovata and S. x hainanensis in Sabah, Malaysia.
- Watanabe, S., et al., 2017. Challenge to support mangrove rehabilitation by drone (unmanned aerial vehicle).

In conclusion, the Conference adopted *the Bali Call to Action for Sustainable Mangrove Ecosystems*, which urged policy-makers, land-use planners, mangrove scientists, international organizations, private sector, donors and coastal communities to re-double their work to ensure the conservation, restoration and protection and sustainable management and use of the world's remaining mangrove forest ecosystems.

![](_page_65_Picture_1.jpeg)

### September 2017 —

The Fourteenth PSC Meeting was held in the Belian Room, SFD Headquarters in Sandakan on 27 September 2017 and chaired by Datuk Sam Mannan, Director of Forestry.

## March 2018 \_\_\_\_\_

The Fifteenth PSC Meeting was held in the Conference Room, Kota Kinabalu District Forestry Office at Lok Kawi, Kota Kinabalu on 29 March 2018 and chaired by Mr Fidelis Edwin Bajau. Earlier, a group of 15 students and seven teachers from Tokyo Metropolitan High School of Science and Technology visited Sabah from 24–29 March 2018.

![](_page_65_Picture_6.jpeg)

The Fifteenth PSC Meeting in Lok Kawi, Kota Kinabalu.

![](_page_65_Picture_8.jpeg)

Students and teachers from Tokyo Metropolitan High School of Science and Technology at the Klias Peat Swamp Centre.

![](_page_65_Picture_10.jpeg)

Students and teachers from Tokyo Metropolitan High School of Science and Technology planting mangroves at Pulau ISME.

#### April 2018

A delegation comprising 17 staff members of SFD visited the mangroves and other places of interest in Peninsular Malaysia from 8–15 April 2018, accompanied by Dr Jin Eong Ong from ISME. Among the mangroves visited were Sungai Merbok Mangroves in Kedah and Matang Mangroves in Perak. The delegation also visited several sites in Penang including The Habitat in Penang Hill, Teluk Bahang Recreational Park, Penang Forestry Museum and Penang Botanical Garden.

![](_page_66_Picture_3.jpeg)

Rhizophora forest at Sungai Merbok (photo by D. Seligi).

![](_page_66_Picture_5.jpeg)

The SFD delegation at Matang in Perak (left) Sungai Merbok in Kedah (right).

#### April 2018 –

The Sixteenth PSC Meeting was held in the Belian Room, SFD Headquarters in Sandakan on 20 August 2018 and chaired by Datuk Mashor Mohd Jaini, the newly appointed Chief Conservator of Forests.

Earlier, Ms Keiko Suzuki and Ms Saori Takatsuto, two senior staff members of Tokio Marine & Nichido Fire Insurance Co., Ltd., Tokyo, visited Sabah from 14–16 August 2018. Among the places of interest visited by these ladies were Kota Kinabalu Wetland Centre, Weston FR, Sungai Klias, Rafflesia Centre, Mt. Kota Kinabalu Park and Lok Kawi Wildlife Park.

![](_page_66_Picture_10.jpeg)

The Sixteenth PSC Meeting. Seated from L–R, Mr Katsuhiko Sato, Prof Shigeyuki Baba, Datuk Mashor Mohd Jaini (Chairperson) and Mr Fidelis Edwin Bajau (left), and Ms Keiko Suzuki and Ms Saori Takatsuto at Pulau ISME (top right) and at KK Wetland Centre (bottom right).

![](_page_66_Picture_12.jpeg)

![](_page_67_Picture_1.jpeg)

### October 2018

On 22 October 2018, Her Royal Highness Princess Maha Chakri Sirindhorn presided over the Foundation Stone Laying Ceremony in Chanthaburi, Thailand. This officially launched the International Mangrove Botanical Garden Rama IX, established in honour of His Majesty the late King Bhumibol Adulyadej. The first in Thailand and probably in the world, the garden covers an area of 83 ha and construction will take three years to complete. One of the objectives of the garden is to serve as a centre for mangrove forest conservation, working in partnership with ISME, which has members from 93 countries around the world. Located in Ban Samet Ngam, Chanthaburi Province, the event was jointly organized by the National Legislative Assembly of Thailand, Ministry of Foreign Affairs, Ministry of Natural Resources and Environment, and the Department of Marine and Coastal Resources.

Present at the ceremony were Prof Sanit Aksornkoae (Member of the National Legislative Assembly of Thailand and President of ISME), Prof Shigeyuki Baba (Executive Director of ISME) and Dr Hung Tuck Chan (Executive Treasurer of ISME). Ambassadors and officials from various embassies in Bangkok were also invited. In Chanthaburi, Prof Shigeyuki Baba gave a talk on ISME, its objectives and activities. A visit to the mangroves of Kung Krabaen Bay Royal Development Study Centre was also made.

![](_page_67_Picture_6.jpeg)

Mangroves of Kung Krabaen Bay Royal Development Study Centre at Thamai in Chanthaburi.

#### March 2019

The Seventeenth PSC Meeting, scheduled to be held in Sandakan on 22 March 2019, was held in the Conference Room, District Forestry Office in Lok Kawi, Kota Kinabalu on 25 March 2019 and chaired by Datuk Mashor Mohd Jaini, the Chief Conservator of Forests. Field trips were organized to visit project activities at Sungai ISME in Sandakan, Sungai Tokio Marine in Kunak and Sungai TBRC in Lahad Datu from 21–23 March 2019. Following the PSC Meeting, SFD and ISME met up with 12 high schools students, five high schools teachers, one high school graduate, and one university student from Tokyo. Together, they planted mangroves at the Borneo Sulaman Cove (BSC) in Sulaman Wetlands, Tuaran on 26 March 2019. They also visited KK Wetlands, Klias Peat Swamp Centre, Sungai Klias, Pulau ISME, Sungai Weston, Mount Kinabalu Park and Lok Kawi Zoo.

![](_page_67_Picture_11.jpeg)

Students and teachers from Tokyo Metropolitan High School of Science and Technology planting mangroves at the Borneo Sulaman Cove (BSC) in Sulaman Wetlands.

#### CALENDAR OF ACTIVITIES

#### August 2019

The Eighteenth PSC Meeting was held in the Auditorium, SFD Headquarters in Sandakan on 23 August 2019, and chaired by Mr Fadzil Hj Yahya, the Deputy Chief Conservator of Forests (Operation). At the meeting, a MoU was signed between SFD and ISME, representing the official launching of Phase Three (2019–2024) of the project. The agenda also included an award ceremony of certificates of appreciation, and handing over of a mock cheque as first payment of the project for 2019.

![](_page_68_Picture_3.jpeg)

Exchange of signed MoU documents between SFD and ISME.

From 27–29 August 2019, staff of Tokio Marine & Nichido Fire Insurance Co., Ltd. (TMNF) visited Kota Kinabalu and nearby areas of Sabah, accompanied by officials from SFD and ISME. Headed by Mr Makoto Okada (Vice-President), the delegation of 41 members from TMNF planted mangroves at Sulaman Wetlands in Tuaran on 27 August and at Pulau ISME in Beaufort on 28 August. At Sulaman Wetlands, the delegation had a rare opportunity to view the release of juvenile mangrove crabs (crablets) supplied by Borneo Marine Research Institute of Universiti Malaysia Sabah (UMS).

![](_page_68_Picture_6.jpeg)

The delegation from TMNF, SFD and ISME at Sulaman Wetlands (left), and at Pulau ISME (right).

![](_page_68_Picture_8.jpeg)

Releasing crablets at Sulaman Wetlands (left) and planting mangroves at Pulau ISME (right).

Committed to the Sustainable Development Goals of United Nations, we continue our efforts in rehabilitating the mangroves of Sabah for a greener world.

![](_page_69_Picture_1.jpeg)

Joseph Tangah, Arthur Y.C. Chung, Shigeyuki Baba, Hung Tuck Chan & Mio Kezuka

![](_page_69_Picture_3.jpeg)

Sabah Forestry Department

![](_page_69_Picture_5.jpeg)

International Society for Mangrove Ecosystems

![](_page_69_Picture_7.jpeg)