The strategic establishment of the Malaysian Mangrove Research Alliance and Network (MyMangrove)

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Abstract: The Malaysian Mangrove Research Alliance and Network (MyMangrove) was established in recognition of the needs for a collaborative effort to significantly influence the management and conservation of mangrove forests through research and education. MyMangrove brings scientists and researchers together, to join forces in exploration and enhancement of scientific knowledge on mangroves and their connecting habitats and ecosystems. The goal of the establishment of MyMangrove is chiefly to close the gap and create a functional and efficient scientific networking among scientists and researchers. It also anticipates at improving public communications on mangrove-related issues and to influence the landscape of policies and regulations pertaining to mangrove management and conservation, particularly in the context of Malaysia. Ultimately, MyMangrove aims at being a strategic platform for the local communities, NGOs, students, corporate sectors and government agencies to collaborate with the multi- and inter-disciplinary group of scientists and researchers from universities and agencies on all matters concerning mangroves and their interconnectedness with other coastal and marine habitats.

Key words: Mangrove; Research; Multi-disciplinary; Inter-disciplinary; Malaysia; MyMangrove.

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INTRODUCTION

Being an intermediate habitat in between land and sea, the mangrove forest requires an interdisciplinary treatment and attention, be it in research as well as in the governance and management of its space and resources (Amir, 2018). The unique diversity of plant, animal and microbial species and the complexity of the ecosystem due to a variety of geomorphological settings as well as the broad range of ecosystem goods and services they provide require an engagement of a multi-disciplinary team of experts to fully describe and consult each and every element of the habitat. This intertidal habitat supports many biological and physical processes including regulation of water and nutrient cycles, species and habitat connectivity, sedimentation and soil stabilisation, plant succession, wave dissipation, and carbon sequestration, to list just a few.

Habitat loss and land-use change are the on-going threats that mangroves are facing in Malaysia (Kanniah *et al.*, 2015; Friess *et al.*, 2020) and throughout the tropics (Feller *et al*., 2017; Curnick *et al*., 2019; Toulec *et al.*, 2020). Geographers, and in particular GIS and Remote Sensing experts, are needed to quantify these changes (Ibharim *et al*., 2015; Otero *et al*., 2018). Together with biologists and ecologists they help also quantifying the biomass and carbon stocks (Hamdan, 2013; Adame *et al.*, 2018; Lucas *et al*., 2020). The mangrove ecosystem carbon stock assessment and quantification study in Malaysia is however still very scarce. Even with few studies done, the methodology adopted varied and resulted in different interpretations, in which they may be overestimated or otherwise.

Environment and natural resource economists are needed to justify the value of the habitat and the Ringgit (MYR) equivalence of the ecological roles of the ecosystem. Environmental scientists contribute to assessing environmental impacts resulting from pollution and other anthropogenic disturbances (Tanaka and Choo, 2000; Wolswijk *et al.*, 2020). Restoration ecologists and foresters are essential to advice rehabilitation measures and silviculture practices (Putz and Chan, 1986; Gong and Ong, 1995; Ong *et al*., 2004; Otero *et al.*, 2019). Social scientists play a very significant role in addressing the social and cultural context of this vital habitat and its local management (Hugé *et al.*, 2016; Martinez Espinosa *et al*., 2020) while environmental policy and legal experts would contribute substantially to bridging mangrove science, policy and management. All in all, mangroves provide a conducive platform for multi-disciplinary research. It offers a great opportunity as an inter-disciplinary rendezvous for scientists, researchers, managers and communities to work together to develop a comprehensive understanding of this unique and special coastal habitat and ecosystem.

Mangrove Research in Malaysia

Malaysian mangroves have been the subject of scientific research and model for forest management since the beginning of the 20th century when a systematic forestry management regime for charcoal and pole production was introduced in Matang, Perak. Since its gazettement as a permanent forest reserve in 1901, Matang mangroves have become a global reference site for ecological research and silvicultural studies (Amir, 2012; Goessens *et al*., 2014; Ismail *et al*., 2017). For almost 120 years now, the forest management practice (through the publication series of the management working plans by the Forestry Department) in Matang mangroves has been referred to (and emulated) by forest authorities in other states, countries and regions.

A landmark publication by J. G. Watson in 1928 entitled ‘Mangrove forests of the Malay Peninsula’ is widely cited by mangrove researchers throughout the world. It is one of the earliest most comprehensive accounts on mangrove species, ecology and forest silviculture for Malaysia. Since then and until the late 1970s unfortunately, no other significant research publication has appeared from Malaysia.

In the final quarter of the 20th century, the establishment of research agencies like the Forest Research Institute of Malaysia (FRIM) and some of the pioneering universities in Malaysia, in particular the University of Malaya and Universiti Sains Malaysia has significantly initiated knowledge exploration on mangroves vis-a-vis management. Though not much research work from this period was published in international indexed journals (Figure 1), there were several research works published as reports by and for the government agencies as well as in the form of undergraduate and master theses by the universities plus other relevant proceedings and monographs. The interests in mangrove research at that point were focused on several themes such as plant taxonomy, species distribution, plant and habitat ecological and physiological characteristics, benthic and faunal organisms as well as on the sediment and geomorphology of coastal and estuarine mangroves. The interest further grew into understanding the connectivity and the complexity of the habitat and the ecosystem at the turn of the century.

The number of fundamental research papers on mangroves were almost stagnant prior to the year 2006 (Figure 1) with the developing interest of the government being on the enhancement of agriculture and aquaculture techniques and commercialisation of products. Incidentally, at this time, much of the mangrove areas throughout the country have already been converted into agriculture and aquaculture lands, as well as utilized for ports, industrial and urban development episodes (Richards and Friess, 2016). Meanwhile, besides law enforcement on forest protection, the forest authorities in Peninsular Malaysia, Sabah and Sarawak continued to enhance knowledge on the effective management approaches to ensure sustainable yield and production of poles and charcoal to be distributed for local and international markets. In 2005, together with researchers at the Forest Research Institute of Malaysia (FRIM), the National Hydraulic Research Institute of Malaysia (NAHRIM) and other government research institutions and universities, the Forestry Department of Peninsular Malaysia embarked on a nationwide scale operation and research to develop techniques for mangrove planting and habitat restoration. One of the key discoveries from this exercise was that hydrology and hydrodynamic were identified as important factors to ensure the growth and survival of the planted mangrove saplings (Awang *et al.*, 2013; Awang 2010).

Despite being acknowledged globally, the understanding, interest and concerns among Malaysians about mangroves and their importance are generally low. Though awareness on the importance of mangroves relatively increased in recent years, it was actually sparked by the devastating tsunami event in December 2004 that hit the northwest coast of Peninsular Malaysia. Correspondingly, the trend and the number of research projects concerning mangroves increased by leaps and bounds immediately after the 2004-2006 period (Figure 1). This is a clear reflection that mangroves gained renewed scientific and management attention globally after the Indian Ocean tsunami (Satyanarayana *et al*., 2013; 2017). Prior to that, Malaysians generally took for granted the rich resources and benefits provided by mangroves, and this is indicated by the lack of historical data and information related to mangroves at all levels.

Mangrove researchers at the universities and research institutes have been working in silos or in small groups, and the force was insufficient to elevate knowledge, to intervene in policy-making and to reach out to a nation-wide audience. The exclusivity of each individual or research group had caused redundancies resulting in differing information and conflicting solutions at localised and national levels. This demands for a better synergy between the different groups working on this special ecosystem. One very apparent issue in the context of Malaysian mangrove research is the inconsistency and/or inaccuracy of data and information. Friess and Webb (2011) identified inaccuracy in data analyses and reporting as a major barrier which would implicate negatively on resource management particularly in policy recommendation and formulation. They further highlighted that this

issue stemmed from: (1) Lack of robust methodology to calculate estimates; (2) Poor traceability of secondary estimates; (3) Significant assumptions of data and information quality; and (4) Propagation of potentially flawed estimates from perceived authorities.

One striking example is on the areal extent of mangroves. Figure 2 showcases a collection of some recent academic articles and government documents that presented the extent of total mangrove area in Malaysia, with some reported subsets of the area gazetted as forest reserves and area under the jurisdiction of the states. The numbers reported were obviously inconsistent and this triggers the question of how accurate these data were. This is just one simple example but indeed a very fundamental issue that needs to be resolved through credible scientific methods and explanation in order for Malaysia to ensure solid protection and management of mangrove resources and their services. It is therefore crucial for scientists and researchers to validate this information and to come to a consensus on how best to consolidate and analyse all key and fundamental data concerning mangroves and other coastal habitats in Malaysia.

The Establishment of The Malaysian Mangrove Research Alliance and Network (MyMangrove)

Realising these and other relevant issues concerning mangrove research and conservation and management of mangroves in Malaysia, the establishment of The Malaysian Mangrove Research Alliance and Network or MyMangrove was initiated to bring mangrove scientists and researchers together, to join forces and efforts for a more comprehensive and integrated understanding on mangroves and their connecting habitats and ecosystems. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) at their 38th General Assembly on the 6th of November 2015 adopted a resolution recognising and proclaiming that 26th July each year is celebrated worldwide as the International Day for the Conservation of the Mangrove Ecosystem.

In conjunction with its second celebration on the 26th of July 2017, a group of Malaysian mangrove and mangrove-related scientists gathered to discuss several fundamental issues concerning mangroves and mangrove research in Malaysia at the Inaugural Workshop of MyMangrove. The honourable Tan Sri Dato' Seri Dr. Salleh Mohd. Nor officially opened and participated in the one-day workshop held at the Danau Golf Club in Universiti Kebangsaan Malaysia, Bangi, Selangor (Figure 3). In his address, Dr. Salleh highlighted the importance of mangroves and the dire need for comprehensive and integrated research, and scientific communications of Malaysian mangroves.

He urged all sectors including the government, corporate and the communities to support MyMangrove's research and conservation agendas for the benefit of our country and future generations. Dr. Salleh spoke based on his vast experience as the former Director-General of Forestry Research Institute of Malaysia (FRIM), former President of the Malaysian Nature Society (MNS), and Chairman of the then National Mangrove Committee (NATMANCOM). He also anticipated for MyMangrove to become a dynamic scientific-based advocate for the sustainability of national, regional and global mangroves.

In the nutshell, MyMangrove is established as a multi-disciplinary scientific core group of researchers from different universities, research institutions and environmental NGOs focusing chiefly on the ecology, conservation and management of mangroves in Malaysia. It promotes collaborative research work between individuals and institutions and allows for a stronger scientific cooperation to intensify knowledge and understanding, and to amplify national appreciation, awareness and sound-scientific conservation. MyMangrove aims to be a hub or a platform for mangrove scientists and researchers to get together to discuss and develop novel ideas and findings, to enhance education and training on mangroves, and to collaborate in research projects, community services, consultation

and policy interventions. Scientific inputs will then be translated into actions for the general public through programs targeting local communities, NGOs, students, corporate sectors and government agencies.

The Progress, So Far

Since the inception in 2017, MyMangrove embarked on identifying individuals and institutions with a primary interest in mangrove and mangrove-related research. MyMangrove Directory and Database (https://forms.gle/dU3xMAcCmRm2tzRC6) was launched to gather information of mangrove enthusiasts, researchers and non-researchers alike, to be part of the research alliance and network. A MyMangrove Facebook Group (https://www.facebook.com/groups/mymangrove/) was established to create a means for communication (Figure 4). At the time of writing, 682 people have become members of the MyMangrove Facebook Group and participated in active discussions and sharing updates on mangrove research including new publications as well as news on mangrove conservation and other relevant issues and matters.

In 2019, MyMangrove organised MyMangrove Monthly Discourse, a series of seminars held monthly to showcase contemporary research on mangroves in Malaysia by researchers at Malaysian universities and research institutes (Figure 5). In 2019 also MyMangrove hosted two International Specialist Series seminars by distinguished international mangrove researchers. The speakers, their institutions and the seminar titles are listed in Table 1. There was an overwhelming response and participation by fellow mangrove researchers, government representatives, students and members of the NGOs and public throughout the series of seminars conducted. There was also involvement by representatives from the corporate sectors as participants in the various seminars. On top of that, the August 2019 seminar was proudly co-hosted with Iskandar Development Authority (IRDA) in Johor Bahru, Johor. MyMangrove as a scientific medium attracts and opens up great opportunities especially for students, researchers and the public to get first-hand information from the other researchers. Highlights and media coverages by the local press (Figure 6) and radio station boosted the presence of MyMangrove which in some ways contributed to the increasing awareness on the importance of mangroves as well as on promoting good mangrove science.

CONCLUSION

Within the two years since its inception, MyMangrove has sparked a lot of interest through conversation, communication and discussions on the past, present and future potential research and management needs on mangrove ecosystems in Malaysia. The monthly discourses in particular have created a means for interaction and brainstorming of new knowledge and research ideas based on the work and findings by fellow researchers within the alliance. As an alliance of researchers, MyMangrove would venture into providing more significant contributions to the scientific world. Several plans are already in place to secure research grants to tackle basic fundamental topics and wider trans-disciplinary themes. Along with the continuous engagement with the authorities, research outcomes should ultimately assist in formulating strong policies for conservation and provide guidelines for proper management and protection of mangroves.

Securing big funding would allow MyMangrove researchers and collaborators to engage in more collaborative research and to participate in exciting expeditions and exploration of fresh and new knowledge. This could then be translated into producing high quality outputs such as textbooks, guidebooks, journal articles, reports and other forms of publication with the sole purpose of enhancing knowledge among scientists and education for the general public which in essence are part of the big MyMangrove's web of network. It is imperative to highlight that the significance of a collaborative nature of MyMangrove

is evident in the successful funding application process. As an example, University of Malaya and Plymouth Marine Laboratory, United Kingdom jointly applied for the Newton Fund Impact Scheme in September 2019 to focus on increasing policy impacts and business engagement in relation to mangrove management in the state of Selangor. The successful securing of the grant can be partially attributed to the strong support provided by MyMangrove in recognition of the importance of the proposed work (Amy Then, pers. comm.). More successful collaborative grant applications and research works are anticipated in the future, including more cooperations with local and international public and private organisations.

Table 1. The list of speakers of the 2019 MyMangrove Monthly Discourse and the 2019 MyMangrove International Specialist Series

2019 MyMangrove Monthly Discourse			
Month	Speaker	Institution	Title
January	Professor Emeritus Dato' Dr. Abdul Latiff Mohamad	Universiti Kebangsaan Malaysia	Biodiversity and Conservation of Mangroves in Malaysia: An Appraisal
Abstract: In Malaysia, unlike other types of forests which are more widespread throughout, the mangrove swamp forests are restricted to the sheltered coasts, islands, estuaries and lower reaches of rivers. It is an important habitat for various terrestrial and aquatic wildlife, including fishes, birds and shells and specialized plant forms including algae, mosses, ferns and seed plants. The mangrove swamp forest of the Langkawi Archipelago alone is home for more than 41 exclusive, 65 non-exclusive and 13 mangrove associates species. As the forests have been degraded, many of them which are endemic, rare, vulnerable, threatened or otherwise are in great perils. It is also of great socio-economic importance as a hydrological regulator, playing a role in flood mitigation, buffering against saline intrusion and even large waves. It is also important for fuel wood, timber resources, and provide a variety of produces used by local inhabitants. Despite these values, mangrove swamp forests are rapidly being cleared for other land-uses, especially agriculture and aquaculture. In view of the recognized values, it is urgent that more suitable mangrove swamp areas are protected for biodiversity conservation purposes. A working plan for the Matang mangrove forest reserve, Perak (Sixth revision) provides a comprehensive overview of the management and conservation of the mangrove ecosystem in Malaysia. In the long term, systematic holistic planning represents the best means of achieving sustainable forest management of mangrove ecosystem incorporating physical and biodiversity conservation and forestry objectives. There are many publications (books and papers in journals) on Malaysian mangroves and currently there is a need for the establishment of Malaysia Mangrove Research Centre, a one-stop centre to house the biodiversity reference collections and also literatures.			
February	Dr. Foong Swee Yeok	Universiti Sains Malaysia	Teluk Air Tawar — Kuala Muda Mangrove and Mudflat: Why It Matters?
Abstract The narrow strip of mangrove and mudflat (M & M) lining the coast of Teluk Ayer Tawar-Kuala Muda (TAT-KM) in the northern inter-state boundary of Penang-Kedah is an internationally recognized Important Bird and Biodiversity Areas (IBA). There are			

many great values of mangroves, and supporting globally endangered water birds is only one of them as in the case of TAT-KM. The Toolkit for Ecosystem Service Site-based Assessment, or TESSA in short, was used to assess several key ecosystem services provided by this IBA. The results from the TESSA exercise had shown that TAT-KM locked a significant amount of carbon in the plants and sediment with an equivalent value of USD 21 million in terms of global climate mitigation. Other natural or existing ecosystem services from fisheries, coastal protection, improvement of water quality, and nature-based tourism totalled up to another USD 6 million annually. We then compared the estimated value of the current state of this site with its most probable alternative use i.e. conversion to shrimp aquaculture ponds. This pilot study showed that the economic value of TAT-KM in its natural or current state was far higher compared to the alternative option. This talk will further elaborate the findings from this study and discuss how they could be incorporated in promoting greater awareness for this precious wetland.

March	Ms. Cheryl Rita Kaur	Maritime Institute of Malaysia (MIMA)	The Relevance of a Particularly Sensitive Sea Area (PSSA) for Enhanced Protection of the Ramsar Sites in the Straits of Malacca

Abstract A Particularly Sensitive Sea Area (PSSA) is defined as an ecologically, economically and scientifically significant area which could be negatively affected by shipping and which requires protection through the action of the International Maritime Organisation (IMO). The concept of the PSSA was originally discussed between 1986 and 1991, with the guidelines for its designation adopted in 1991 and subsequently revised in 2005. The guidelines specify the means for designating a PSSA, stipulate possible vulnerabilities to international shipping and propose measures to protect the area from the impact of shipping. To date, there are 17 areas (including extensions) around the world listed as PSSAs. This presentation describes the procedures and criteria for designating a PSSA, analyses related issues, and informs on Malaysia's current initiatives on identifying and designating a PSSA in the Straits of Malacca under the framework cooperation agreement between IMO and the Norwegian Agency for Development Cooperation (NORAD). The areas identified include Pulau Kukup (Kukup Island) and Tanjung Piai (Cape Piai) National Parks at the southern tip of Peninsular Malaysia. An overview of the environmental significance in these areas and the need to protect the parks from increasing pressures from international shipping in the Straits are outlined. Recent developments surrounding the identified areas, as well as the policy and management gaps and challenges are further discussed.

April	Associate Professor Dr. Behara Satyanarayana	Universiti Malaysia Terengganu	Unmanned Aerial Vehicles: A Revolutionary Approach for Mangrove Studies

Abstract Remote sensing data were extremely useful for mangrove conservation and management. Besides the satellite data that often limited by cloud cover to study mangrove ecosystems, the aerial photos have been widely used for mangrove and non-mangrove area delineation, species-level mapping, area estimations, etc. However, acquisition of the aerial photos through aircrafts is an expensive effort and therefore unavailable for many mangrove locations, especially in the recent years. Under these circumstances, the revolutionary mode of remote sensing data acquisition through Unmanned Aerial Vehicles

(UAVs) or drones was found beneficial not only for reducing the cost of aerial photography, but also the cost of equipment due to regularly updated models in the market. In last two years, the number of mangrove studies using drones increased remarkably. For the present talk, I would like to share some findings of the drone-based research works carried out from Setiu wetlands (Terengganu) and Matang Mangrove Forest Reserve (Perak) in Peninsular Malaysia. In the case of Setiu, a comparative study on the utility of DJI-Phantom-2 drone imagery (spatial resolution: 5 cm) and Pleiades-1B satellite imagery (spatial resolution: 50 cm) for species-level mapping was made. Both object- and pixel-based classification approaches were tested and found that object-based classification (with manual rule-set algorithm) of the drone imagery provided a highest accuracy (94.0±0.5%) as compared to the Pleiades imagery (72.2±2.7%) for dominant land-cover features (i.e., water, land, *Avicennia alba, Nypa fruticans, Rhizophora apiculata and Casuarina equisetifolia*). Also, pixel-based classification (with maximum likelihood algorithm) of the drone imagery provided better accuracy (90.0±1.9%) than to the Pleiades (82.8±3.5%). For Matang Mangrove Forest Reserve, the DJI-Phantom-3 drone imagery (spatial resolution: 2 cm) was utilized for retrieving mangrove biophysical properties such as tree height and biomass. In terms of tree height, the drone produced results (13.7 m) close to the ground-truth observations (14 m) in a productive (15-year old) forest stand than to the virgin (90-year old) jungle. Also, the above ground biomass observed from drone (217 Mg ha-1) and ground-truth (238 Mg ha-1) were rather close for the productive forest than to the virgin jungle. Overall, the drone acquired data were proven to be a viable alternative to satellite-based monitoring and management of the mangrove ecosystems.

May	Dr. Sahadev Sharma	Universiti Malaya	Malaysia's Mangrove Blue Carbon Research: Knowledge Gaps and The Way Forward

Abstract The total ecosystem carbon (TEC) stocks of mangroves vary substantially across the world's regions and within countries. For instance, TEC stocks range from 442 to 1267 Mg C ha^{-1} across Southeast Asian mangroves, and from 154 to 1484 Mg C ha^{-1} in the West to Central African mangroves. Mangrove TEC stocks within Indonesia vary from 593 to 1397 Mg C ha^{-1}. The wide range of TEC stocks being reported across the globe is partly due to some countries having a very small sample size consisting of only a few study plots or transects. The Intergovernmental Panel on Climate Change (IPCC) good practice guidelines, and the United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines emphasize the need to ensure that TEC stock assessments are complete, consistent, comparable, accurate, and transparent. Thus, to better understand the potential values of these ecosystems in mitigating climate change, a standard method must be used to quantify TEC stocks for Malaysian mangroves. The results from the TEC stocks study should be included in Malaysia's nationally determined contributions (NDCs) to the UNFCCC, and use as a basis to formulate the mechanism for payments for ecosystem services (PES) that financially incentivize our efforts in the conservation and protection of mangrove forest.

June	Professor Dr. Ahmad Ismail	Universiti Putra Malaysia	Managing Issues and Conflicts on Mangrove Conservation in Malaysia

Abstract More integrated and collaborative research are needed to support the management and conservation of mangroves in Malaysia. With the new and emerging technologies, creativity, public concerns, good laws and regulations, and participation by local and global experts, a comprehensive plan for long-term mangrove research, management and conservation can be established. Information on all aspects of mangroves needs to be systematically collated, managed and synthesised to tackle issues ranging from biodiversity loss to socioeconomy, public awareness to government policies, and from local to global challenges like erosion, pollution, sea level rise and other climate crises. Considering the multiple roles and benefits provided by mangroves, as supported by concrete scientific knowledge, more mangrove habitats must be protected. For instance, the mangroves in Telok Air Tawar in Penang, Kuala Gula in Perak, and Kuala Selangor in Selangor, among others, are on their way to be established as Ramsar sites. These sites possess tremendous ecological and economic values, worthy to be conserved for their global significance in providing various ecosystem services and as important bird and biodiversity areas (IBAs).

July	Pn. Nor Aslinda Awang Mr. Wan Ahmad Hafiz Wan Mohamed Azhary Pn. Anizawati binti Ahmad Mr. Dunstan Anthony	National Hydraulic Research Institute of Malaysia (NAHRIM)	Hydrodynamics in Mangrove and the Threats from Sea Level Rise

Abstract Hydrodynamic numerical modelling is a crucial mechanism and indicator to be considered for use as a guideline in the rehabilitation of mangrove forests in Malaysia. Rising sea level poses a threat as the cause of changes in the inundation pattern, speed and wave height which affects the growth and the survival of mangroves and coastal habitats. Consequently, this will have significant socio economic impacts on the surrounding communities. Although studies have shown that mangroves can migrate landward and promote sedimentation, mangroves in Malaysia however have very limited space to move or expand due to the establishment of bunds, revetments, and settlements. A study carried out by NAHRIM in 2012 indicated that an increase of 0.5 m in sea level will affect 53% of the 1800 ha of mangroves in Sandakan, and, in addition to that, salt water is estimated to intrude 6 km upstream of Muar River by the year 2100.

August	Prof. Dr. Kasturi Devi Kanniah	Universiti Teknologi Malaysia	Remote Sensing Technology for Managing Mangrove Forests in Malaysia

Abstract : In this talk the availability of various remotely sensed data (ranging from optical and radar satellite images, terrestrial and airborne Lidar data, to data captured by unmanned aerial vehicle) and practical techniques to (i) map and monitor the extent of mangrove forest and its leaf area index, (ii) classify various mangrove species, (iii) estimate vertical structure and biomass/carbon stock/fluxes, (iv) retrieve the health condition of mangrove, (v) estimate evapotranspiration and (vi) assessing the impact of climate change on mangroves are presented. The limitations of the datasets are also discussed in this talk. Finally, some insights into the future studies due to the advancement in remote sensor technology are presented. This information will provide economists, ecologists, and natural resources managers in Malaysia with valuable information to improve management strategies for mangrove ecosystems.

September	Dr. Amy Then	Universiti Malaya	Mangrove, Macroinvertebrates and Men: Recent Insights on Mangrove Restoration and Conservation

Abstract Although multiple ecosystem services of mangroves are widely recognized, including provisioning of habitat for juvenile invertebrates and fishery resources for coastal livelihoods, mangrove loss continues to persist especially in the face of urbanisation. Mangrove restoration is often discussed in the context of the mangrove habitat itself but proper focus is also needed on the animal and human dimensions. This talk will discuss key findings on these aspects using two very different approaches. Stable isotope work applied in a chronosequence of replanted mangrove plots in the Matang Mangrove forest in Perak revealed that crabs and gastropods are highly suitable indicators of faunal food web recovery. Timing of this recovery took place between 5 and 15 years post-clearing of mangroves which tracked physicochemical changes of the forest. The novel use of the triple HCN isotope measurements revealed for the first time the role of mangrove-linked microbial loop in supporting faunal food web. Social-science approaches, using participatory workshops and interview surveys among local stakeholders, were applied in the highly anthropogenised Klang Islands where severe mangrove loss had been seen in the last 20 years. Generally, local villagers acknowledged the importance of mangroves but accepted the state of loss and hardships given the necessity of infrastructure development. An unexpected finding was the bleak consensus of disappearing fishery as an important livelihood. There is urgent need for improved recognition of the socio-ecological aspects of mangrove ecosystem services and to shape sustainable mangrove management through more inclusive practices.

October	Dr. Harinder Rai Singh	Universiti Teknologi MARA	Mangroves: The Importance of Replanting to Fauna, Fisheries, Livelihoods, etc.

Abstract Malaysia's mangrove restoration seriously kicked off in 2005 after the 2004 Boxing Day tsunami which highlighted the importance of mangroves and the need for their conservation for coastal protection and the consequences of their lack of. As of 2016, the Forestry Department of Peninsular Malaysia (JPSM) together with various stakeholders has replanted 5,962,493 trees covering 2,104.11 ha. Besides replanting, information on recruitment patterns of fauna (invertebrates and vertebrates) is imperative to understand temporal changes within these habitats to gauge impacts on natural mangrove stands. The importance of mangroves is at multiple levels, for example, ecological roles to fisheries, mangrove size and correlation to coastal fisheries, connectivity of coastal habitats, carbon sequestration, etc. Notwithstanding mangroves being important for small scale fisheries, mangrove artisanal fish catch is not well documented noting that replanting of mangroves may enhance such fishery. Besides the articles of law, the role of science communication and education in sustaining, protecting and conserving a country's mangrove ecosystem for its ecosystem services is urgently needed.

November	Mr. Mohammad Shahfiz Azman	Forest Research Institute of Malaysia (FRIM)	Mangroves of Bagan Datuk, Perak: A Hotspot for Fauna?

Abstract There are at least 79 species of birds, 11 species of herpetofauna and 20 species of mammals including iconic mangrove faunas such as mangrove flycatcher, mangrove pit-viper and silver-leaf langurs, recorded from the mangroves of Bagan Datuk in Perak. This

is the first comprehensive record comprising the three vertebrate taxa for this area. Numerous samplings have been carried out and methods being applied since 2018 such as active trappings and direct observations using harp traps and binoculars. Relatively high in diversity and abundance—considering the size of the mangrove forest, it is therefore crucial to protect this area as an important habitat for these mangrove faunas. Currently, the mangrove area at Bagan Datuk is not legally protected, and the habitat is threatened by uncontrolled utilisation such as over-fishing, collection of stingless bees, animal trapping and land use change. The finding provides a strong need for this area to be protected, perhaps to be gazetted as a forest reserve, or through other form of legal land and resource protection by the state. Alternatively, taking Bali's Monkey Forest as an example, Bagan Datuk mangroves could also be managed for sustainable eco-tourism purposes—a great showcase of its species and wildlife diversity.

2019 MyMangrove International Specialist Series			
30th August	Associate Professor Dr. Alison Wee	Guangxi University, China	Mangroves in a Changing World: Population Genetics and Phylogeography of Malaysian Mangroves in the Global Arena

Abstract Understanding the drivers and limitations of gene flow, phylogeography and genetic adaptation is crucial to effectively manage the threats and conserve the long-term evolutionary potential of mangroves. This talk summarizes research findings in the past decade on key mangrove species in Malaysia (*Avicennia alba, Sonneratia alba, Bruguiera gymnorhiza, Rhizophora mucronata* and *Rhizophora stylosa*), comparing their genetic patterns to those observed in the Indo-West Pacific region. These studies demonstrated that low propagule dispersal capabilities, land barriers and ocean currents may restrict gene flow in mangroves and underscores the importance of long distance dispersal in connecting fragmented populations. The second part of the presentatiōn describes my current work in understanding the response to low temperature and drought stresses in mangroves at its distribution range limits. Through the application of ecological genomics, we examined the molecular mechanism for stress adaptation to explain the wide distribution of mangroves and to estimate the future adaptive potential of mangroves under climate change.

15th July	Prof. Dr. Farid Dahdouh-Guebas	Université Libre de Bruxelles (ULB) and Vrije Universiteit Brussel (VUB), Belgium	Ecological Insights from 3 Decades of Remote Sensing in Kenyan, Sri Lankan and Malaysian Mangrove Forests

Abstract Since the rise of remote sensing, the monitoring and management of mangrove forests world-wide has been aided by remotely sensed imagery. In this presentation, we provide a zoom from historic aerial photography, over space-borne imagery, up to state-of-the-art Unmanned Aerial Vehicle (UAV) drone technology. Using case-studies from Kenya, Sri Lanka and Malaysia, and linking to interdisciplinary methods with respect to fieldwork and socio-ecology, we provide an overview of the challenges of (1) identification of mangroves trees, (2) pinpointing functional degradation of forest patches, and (3) estimating/calculating reliable silvimetric indices. Overcoming these three challenges are paramount in successful (remote sensing-based) mangrove management and governance.

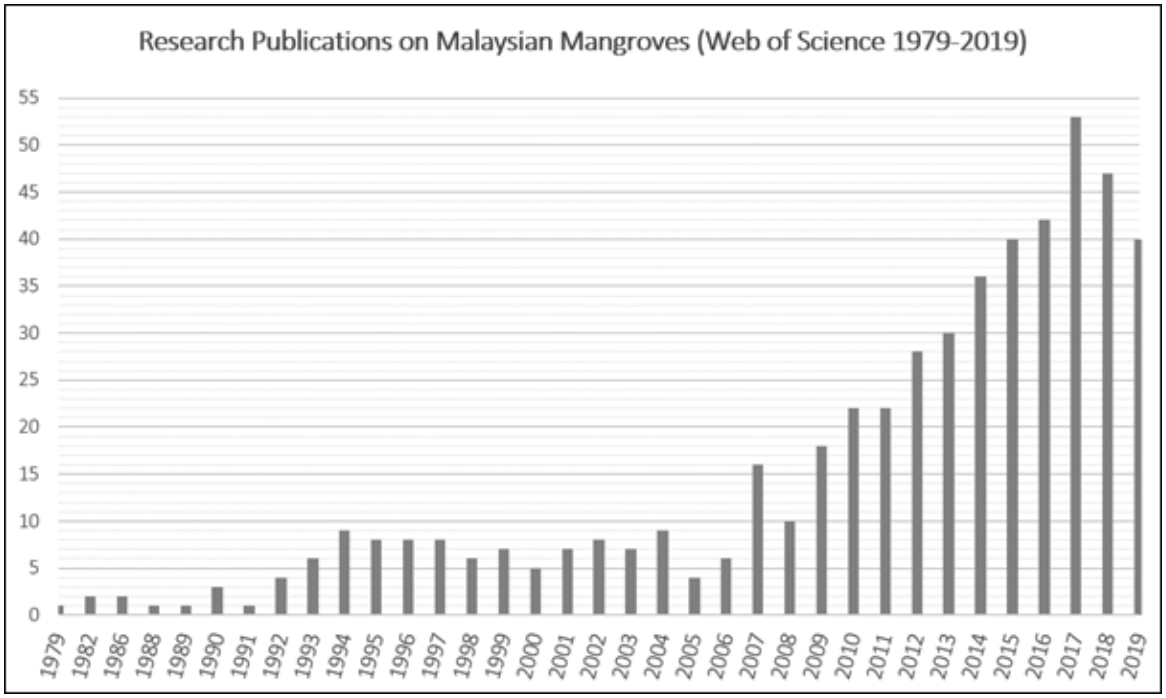

Figure 1. The number of research publications related to Malaysian mangroves from 1979 until 2019 (n=520). Source: Web of Science (Access date: 15th March 2020) (Keywords: [Topic:"Mangrove"]AND[Topic:"Malaysia"]).

Table 1: Extent of mangrove forest reserves and stateland mangroves in Malaysia (Area in hectares - ha)

State	Forest Reserve	Stateland	Total
Johore	17,029	8,050	25,079
Kedah	7,949	-	7,949
Kelantan	-	-	-
Malacca	338	100	438
Negeri Sembilan	540	727	1,267
Pahang	2,483	8,990	11,473
Penang	451	-	451
Perak	43,502	-	43,502
Perlis	-	-	-
Selangor	15,090	-	15,090
Terengganu	1,295	-	1,295
Sabah	317,423	49,927	367,350
Sarawak	34,992	133,000	167,992
TOTAL	**441,092**	**200,794**	**641,886**

Abdul Shukor 2004

250 *Chong / Aquatic Ecosystem Health and Management 9 (2006) 249–260*

Table 1. Mangrove forest area and reserves in Malaysia; [a] = Tan and Buainon (2000); [b] = Chan et al. (1995); [c] = Ooi (1996).

Region	State	Total Length of Coastline (km)[c]	Gazetted Forest Reserve (ha)[c]	Stateland (ha)[a]	Total (ha)	Density (ha km^{-2})	Gazetted Reserves[b]
Peninsular Malaysia	Perlis	20	0	20	20	1.0	0
	Kedah	148	7,248	400	7,648	51.7	11
	Penang	152	451	500	951	6.3	1
	Perak	230	43,500	150	43,650	189.8	21
	Selangor	213	15,090	4,500	19,590	92.0	15
	Negri Sembilan	58	454	200	654	11.3	3
	Melaka	73	166	100	266	3.6	2
	Johor	492	17,832	6,500	24,332	49.5	10
	Pahang	271	2,675	2,000	4,675	17.3	11
	Terengganu	244	1,295	1,000	2,295	9.4	1
	Kelantan	71	0	100	100	1.4	0
East Malaysia	Sarawak	1035	73,000	59,000	132,000	127.5	11
	Sabah	1743	328,658	12,719	341,377	195.9	26
	Labuan	59	0	0	0	0.0	0
	Total	4,809	490,369	87,189	577,558	120.1	112

Chong 2006

No.	Country	Area (ha)	Global total (%)
1	Indonesia	3,189,400	20.9
2	Brazil	1,300,000	8.5
3	Australia	991,000	6.5
4	Mexico	770,100	5.0
5	Nigeria	735,600	4.8
6	Malaysia	709,700	4.7
7	Myanmar	502,900	3.3
8	Bangladesh	495,100	3.2
9	Cuba	494,400	3.2
10	India	432,600	2.8
11	Papua New Guinea	426,500	2.8
12	Colombia	407,900	2.7

Modified from: Spalding et al. (2010)

Hamdan et al. 2012

2000 MPW rank	Country name	2000 MPW km^2	2000 MPW Percentage	2000 Biome km^2	2000 Biome Percentage	2014 MPW km^2	2014 MPW Percentage	2014 BIOME km^2	2014 BIOME Percentage
1	Indonesia	24,073	28.83	46,642	26.95	23,143	28.40	42,278	25.79
2	Brazil	7721	9.25	18,168	10.50	7686	9.40	17,287	10.55
3	Malaysia	4969	5.95	8738	5.05	4691	5.76	7616	4.65
4	Papua New Guinea	4190	5.02	5982	3.46		5.12	6236	3.80
5	Australia	3527	3.98	3539	3.94	3315	4.07	3314	2.02
6	Mexico	3021	3.62	6240	3.61	2983	3.66	6036	3.68
7	Myanmar	2793	3.34	4205	2.43	2508	3.08	3783	2.31
8	Nigeria	2657	3.18	6944	4.01	2653	3.26	6908	4.21
9	Venezuela	2404	2.89	7579	4.38	2401	2.95	7116	4.39
10	Philippines	2091	2.50	2115	1.22	2060	2.53	2084	1.27
11	Thailand	1953	2.32	4362	2.52	1876	2.30	3936	2.40
12	Bangladesh	1774	2.12	2317	1.34	1773	2.18	2314	1.41
13	Colombia	1674	2.01	6313	3.65	1672	2.05	6236	3.80
14	Cuba	1660	1.99	2471	1.43	1624	1.99	2407	1.47
15	United States	1612	1.93	1616	0.93	1553	1.91	1534	0.93
16	Panama	1328	1.59	2768	1.60	1323	1.62	2673	1.63
17	Mozambique	1226	1.47	2736	1.57	1223	1.50	2658	1.62
18	Cameroon	1119	1.34	1344	0.78	1113	1.37	1323	0.81
19	Gabon	1087	1.30	3929	2.27	1081	1.33	3864	2.36
20	Ecuador	958	1.12	1971	1.14	955	1.15	1906	1.16
	Total	71,608	85.76	139,727	80.76	69,761	85.61	131,931	80.48

MPW, Mangrove Forests of the Word (Landsat-based mangrove database).

Hamilton & Casey 2016

Jadual 3.1: Keluasan HPL Di Malaysia

Negeri	Kawasan HPL (ha)	HSK/TPA (ha)
Johor	32,301	31,915*
Kedah	11,729	6,201*
Kelantan	744	-*
Melaka	136	136*
Negeri Sembilan	101	101*
Pahang	2,416	2,416*
Pulau Pinang	1,045	1,045*
Perak	43,669	42,232*
Perlis	10	-*
Selangor	23,648	18,998*
Terengganu	1,987	1,037 *
Sabah	331,325	280,002**
Sarawak	88,575	25,400***
JUMLAH	537,686	409,483

Nota:
* Jabtan Perhutanan Semenanjung Malaysia, 2015
** Jabatan Perhutanan Sabah, 2016
*** Jabatan Hutan Sarawak, 2016

Ministry of Natural Resource and Environment 2016

States	Mangrove PFRs and PAs (ha)
Johor	31,915
Kedah	6,201
Kelantan	-
Melaka	135
Negeri Sembilan	101
Pahang	2,416
Perak	43,878
Pulau Pinang	1,045
Selangor	18,998
Terengganu	1,037
Peninsular Malaysia	105,726
Sabah	403,873
Sarawak	72,545
Malaysia	582,144

Compendium of Environmental Statistics 2017

Table 2. Extents of mangroves in Malaysia

Region	Mangroves 1990 (ha)	Mangroves 2000 (ha)	Mangroves 2017 (ha)
Peninsular Malaysia	115,418	113,046	109,482
Sabah	385,630	382,448	378,195
Sarawak	147,936	145,263	139,890
Total	648,984	640,757	627,567

Omar et al. 2018

Figure 2. Inconsistent data and information on the area extent of mangroves in Malaysia.

Figure 3. Participants at the inaugural workshop for the establishment of the Malaysian Mangrove Research Alliance and Network (MyMangrove) held on the 26th July 2017 at Danau Golf Club, Universiti Kebangsaan Malaysia, Bangi, Selangor. The event was held in conjunction with the second International Day for the Conservation of the Mangrove Ecosystems held every July 26th.

Figure 4. The Facebook Group welcome page for The Malaysian Mangrove Research Alliance and Network (MyMangrove). Interested researchers and mangrove enthusiasts are welcome to join and be part of this group (https://www.facebook.com/groups/mymangrove/).

Figure 5. A collage of all the posters calls for the 2019 MyMangrove Monthly Discourse and the 2019 MyMangrove International Specialist Series seminars.

Figure 6. Members of the media do play a significant role as mass-media coverages on mangroves and MyMangrove contribute to increasing awareness among the general public (Sources: The Star and New Straits Times).

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