THE ASIAN NETWORK FOR USING ALGAE AS A CO_2 SINK

THE ASIAN PACIFIC PHYCOLOGICAL ASSOCIATION

부산대학교
PUSAN NATIONAL UNIVERSITY

This Newsletter was supported by the Project "Study on the Mitigation and Adaptation Measures Using Seaweeds: Korea-ASEAN Network", National Research Foundation of Korea, and Marine Research Institute, Pusan National University.

Newsletter

Issue No. 10 February 1, 2016

Message from the President of The Asian Pacific Phycological Association

Sung Min Boo

Ocean acidification poses an increasing threat to human life as well as marine ecosystems in the future. An estimated 30-40% of the carbon dioxide released by human activities into the atmosphere dissolves mostly into ocean, and surface ocean acidity (pH), estimated approximately 8.25 in 1751, is expected to decrease to 7.824 in 2100.

The Asian Network for Using Algae as a CO_2 Sink is a working group set up under the auspices of the Asian Pacific Phycological Association (APPA). The main objectives of the Asian Network are to address how much carbon dioxide is being absorbed from the atmosphere by seaweeds and to look for ways that sea plants can control greenhouse gases, which are blamed for ocean warming and acidification. The idea is that seaweeds absorb ocean carbon by photosynthesis and approximately 8 million metric tons of seaweeds are harvested annually from the wild and seaweed farms. The Asian Network is an international working group that comprises 15 members from 12 countries in Asian and Australasian regions. A Korean research group has initiated this Network and led the working group since its establishment in Bangkok, Thailand during the 4th Asian-Pacific Phycological Forum, 2004.

The APPA is very pleased by the role that the Asian Network for Using Algae as a CO_2 Sink has played in contributing to marine biological and phyological research in the region. Our colleagues in Korea are to be congratulated for their vision and their continued efforts and time in developing and maintaining this network, and in communicating the issues widely in international meetings and through exchanging visits between committee members or related scientists.

I am so impressed by the organizing committee of the network who is preparing the 3rd workshop/ symposium to be held in Kuala Lumpur, Malaysia during 20-21 February, 2016. The program for this meeting will include i) the project review and the activities of the Asian Network, ii) the collaborative research on the mitigation and adaptation measures using seaweed, and iii) discussion on future programs and priorities for the network. Participants will bring a brief report of each member and his/her country's current activities related to the working group, CO_2 sequestration by seaweeds and blue carbon.

Sung Min Boo
President, Asian–Pacific Phycological Association

APPA

The 2nd Korea-ASEAN International Workshop "Climate changes, Seaweed and CO_2 Sequestration"

The second workshop of Korea-ASEAN International Workshop on "Climate changes, Seaweed and CO_2 Sequestration was held at Bailu Hall, East Lake International Conference Center, East Lake Hotel, Wuhan, China, September 19-20, 2014.

SESSION 1 Current status of seaweeds as mitigation measures in the Korea-ASEAN and APPA countries
Moderator : JA Lee (Inje University, Korea)
Country Report Summary (IK Chung, Pusan National University, Korea)
Synthesized report of seaweed aquaculture beds as mitigation measures (C Sondak, Pusan National University, Korea)
Round Table Discussion

Invited Lecture
Moderator : G Du (Ocean University of China, China)
Interactive effects of ocean acidification with solar radiation on primary producers (K Gao, Shantou University, China)
SESSION 2 Seaweed Blue Carbon and adaptation measures in the Korea-ASEAN and APPA countries
Moderator : W Nelson (National Institute of Water and Atmospheric Research, New Zealand) and H Kawai (Kobe University, Japan)

Introduction and seaweed production, carbon removal and sequestration in Korea (IK Chung, Pusan National University, Korea)
Malaysia Country Report (SM Phang and PE Lim, University of Malaya)
Vietnam Country Report - Contribution of algal mass cultivation to CO_2 capture in Vietnam (DD Hong, Vietnam Academy of Science and Technology, Vietnam)
Australia Country Report (A Bellgrove, Deakin University and J Beardall, Monash University, Australia)
China Country Report (Z Hu, Institute of Hydrobiology, CAS, China)
Hong Kong Report (P Ang Jr, The Chinese University of Hong Kong, Hong Kong)
India Country Report (D Sahoo, University of Delhi, India)
Indonesia Country Report (GS Gerung and C Sondak, Sam Ratulangi University, Indonesia)
Japan Country Report (H Kawai, Kobe University, Japan)
New Zealand Country Report (W Nelson, National Institute of Water and Atmospheric Research and C Hepburn, University of Otago, New Zealand)

Discussion and Planning for next meeting and other activities

1

2

1-2. The 2nd Korea-ASEAN International Workshop on "Climate changes, Seaweed and CO_2 Sequestration" was held at East Lake International Conference Center, Wuhan, China, September 19-20, 2014.

The 1st International Seaweed Ranching and Bioremediation Conference and The 2nd International Symposium of Advanced Research on Green Tides

Some macroalgae have bloomed without control in the Yellow Sea, China for nine consecutive years from 2007, forming large scale floating green tides, with maximum coverage area of 2,100 ㎢. The 1st International Seaweed Ranching and Bioremediation Conference and the 2nd International Symposium of Advanced Research on Green Tides were jointly organized by Shanghi Ocean University and Huaihai Institute of Technology at Shanghai and Lianyungang, China, October 9-11, 2015, mainly to recognize the blooming mechanism of green tide and the utilization of green tide seaweed.

The 1st International Seaweed Ranching and Bioremediation Conference Conference Center, Huaihai Institute of Technology

Plenary Lectures (Chair: Prof. Binlun Yan)

Prof. Ik Kyo Chung (Korea)
Potential blue carbon from coastal ecosystems in the Republic of Korea

Prof. Guangce Wang (China)
The economic seaweed aquaculture in China

Prof. Motoharu Uchida (Japan)
Research on fermentation for wise utilization of seaweeds including green algae

Prof. Jang K. Kim (US)
Nutrient bioextraction by seaweed aquaculture in urbanized estuaries in Northeast America

Invited Lectures (Chair: Prof. Jin Ae Lee)

Prof. Juntian Xu (China)
The adaption of photosynthetic physiology of *Ulva linza* in different life histories to long-term ocean acidification

Prof. Jong Ahm Shin (Korea)
Cultivation and utilization of green algae in Korea

Prof. Tao Liu (China)
Complete plastid genome of *Costaria costata* indicates a possible mechanism of plastid gene length mutation

Prof. Shogo Arai (Japan)
Utilization and effect of seaweeds including green algae as mineral fertilizer

Dr. Tae-Gun Oh (Korea)
Sea forestration project in Korea

Prof. Yufeng Yang (China)
The key biogeochemical processes in the cultivation ecosystem of seaweed *Gracilaria lemaneiformis* and the bioremediation effects

Prof. Chen Changsheng (China)
Studies on repair, rebuild, and recovery efficiency and technology of large seaweed meadow ecosystem

Invited Lectures (Chair: Prof. Yufeng Yang)

Prof. Yoshimura Taku (Japan)
Recent shift from bottom-up to top-down control of the algal community and current condition of algal bed restoration around Kyusyu, south-western Japan

Prof. Enyi Xie (China)
Restoration techniques for seaweed beds of *Sargassum* on artificial reefs

Prof. Jin Ae Lee (Korea)
Carbon dioxide mitigation potential of seaweed aquaculture beds (SABs) in the Asian Pacific countries

Prof. Ming Zhu (China)
How *Ulva prolifera* adapt to reduced salinity and eutrophication?

Dr. Liwis Sun (China)
Experimental transplants of the *Gracilaria salicorniain* in low energy wave exposed mudflat of Liusha Bay, China

Prof. Peimin He (China)
Studies on seaweeds year-round cultivation bioremediation model based on *Pyropia yezonsis* ranching in Jiangsu coasts, China

The 2nd International Symposium of Advanced Research on Green Tides
Library and Information Center, Shanghai Ocean University

Plenary Lectures (Chair: Prof. Dongyan Liu)

Prof. Peimin He (China)
Species population succession trend for green tide blooming in the Yellow Sea

Prof. Yannick Lerat (France)
Green macroalgal bloom on French Coast

Prof. John K. Keesing (Australia)
Spatial and temporal trends in green tide biomass accumulation and bloom dynamics provide direction for future research and mitigation measures

Prof. Senjie Lin (US)
What can algal genomics tell us about algal blooms?

Invited Speeches (Chair: Prof. Senjie Lin)

Prof. Guangce Wang (China)
The reproductive pathways of free-floating *Ulva prolifera* and the response mechanisms to stress

Prof. Alwyn Rees (New Zealand)
Macroalgal blooms: Lessons from New Zealand

Mr Liu Caicai (China)
Preliminary study on prevention of adhesion and growth for green tide algae

Prof. Dongyan Liu (China)
The world's largest macroalgal bloom in the Yellow Sea, China: Formation and implications

Prof. Goro Yoshida (Japan)
Ecological studies on *Ulva* green tide in Hiroshima Bay, Seto Inland Sea, Japan

Prof. Nianjun Xu (China)
Effects of phytohormones and environmental factors on the physiology in green alga *Ulva prolifera*

Invited Speeches (Chair: Prof. Alwyn Rees)

Prof. Zongling Wang (China)
Distribution of green algal micropropagules in the Yellow Sea and the function in green tide initiation

Prof. EunJu Kang (Korea)
Effects of salinity and nutrients on photosynthesis and growth of the green tide species in the Yellow Sea during morphogenesis

Prof. Peng Jiang (China)
Genetic analyses of floating *Ulva prolifera* in the Yellow Sea suggest a unique ecotype

Prof. Peng Zhao (China)
The green tide monitoring and forecasting in the Yellow Sea

Dr. Yi Yang (France)
Economic analysis of green tides phenomenon in Brittany region (France) and along the coastal zone of the Yellow Sea

Dr. Wenrong Zhu (Japan)
A comparative study of growth characteristics in *Ulva prolifera* and *U. meridionalis*

3


4


5

3-5. The 1st International Seaweed Ranching and Bioremediation Conference and the 2nd International Symposium of Advanced Research on Green Tides were jointly organized by Shanghi Ocean University and Huaihai Institute of Technology at Shanghai and Lianyungang, China, October 9-11, 2015.

Seaweed Blue Carbon and Adaptation Measures in the Korea-ASEAN and APPA countries: MALAYSIA COUNTRY REPORT

Siew-Moi Phang, Phaik Eem Lim & Hui-Yin Yeong
Institute of Ocean and Earth Sciences, University of Malaya
February 2016 [Updated from the 2014 Report]

1. Introduction

More than 386 taxa of marine algae (seaweeds) are found in Malaysian waters; Chlorophyta: 13 families, 102 taxa; Rhodophyta: 27 families, 182 taxa; Phaeophyta: 8 families, 85 taxa; and Cyanophyta: 8 families, 17 taxa (Phang 2006, Phang et al., 2007). They are found in various habitats ranging from rocky shores, coral reefs, sandy shores, mudflats, mangroves, to estuaries. A Seaweed and Seagrasses Herbarium has been established at the University of Malaya. It houses more than 10,000 specimens and supports the biodiversity, systematics, phylogenetics, ecology and biotechnology research in the university. It is also the main reference centre for the identification and systematics studies of Malaysian and tropical seaweeds in the country. This herbarium supports the activities of the Consortium of Southeast Asian Seaweed Taxonomy (SEASTAX) under the auspices of the Asian-Pacific Phycological Association (APPA). Research on the taxonomy, systematics and phylogenetics of the Malaysian seaweeds have been published by the University of Malaya Algae Research Group. The Malaysian seaweed resources have also been organized into a database as well as mapped using GIS (Du et al., 2008).

Commercial seaweed farming is located mainly in east coast of Sabah, East Malaysia. The seaweed farming areas of East Malaysia contributes to the high global production of carrageenan by the Coral Triangle (Phang et al. 2010). In 2009, the total production of *Kappaphycus* within the Coral Triangle was 200,000 MT, and the production by country is as follows: Indonesia (54%); Philippines (40%); Malaysia (3%), Solomon Islands (1%); and Timor Leste (1%). Papua New Guinea has just started trial plots in the Alatau area in August 2010. The populations within the Coral Triangle are also amongst the poorest in the region, and seaweed farming is an important avenue for poverty eradication.

Seaweed farming is one of three priority development areas for the agriculture sector in Malaysia. Through an Economic Transformation Program (EPP 3: Mini-Estate Farming for Seaweed), driven by Department of Fisheries (DoF), Malaysia aims to transform the seaweed farming industry into a high-yielding commercial-scale business by clustering farms under the seaweed mini-estate initiative. Through this initiative, total production of seaweed is expected to rise from 13,500 metric tonnes in 2010 to 150,000 metric tonnes in 2020. Measures under this EPP place emphasis on improving downstream infrastructure and research and development (R&D) efforts to process dry seaweed into high-value products (e.g. semi-refined carrageenan and alkaline-treated chips), as well as exploring further uses of seaweed. In line with this, this EPP's project team has targeted the production of 8,640 MT of alkaline treatment chips and semi-refined carrageenan.

Other efforts undertaken for this EPP include plans by the Sabah State Government to gazette another 3,000 ha of land for seaweed production. Meanwhile, three universities, The National University of Malaysia (UKM), Universiti Malaysia Sabah (UMS) and Universiti Sains Malaysia (USM), are in the midst of commercialising eight seaweed products.

2. Estimate carbon stored and sequestered in wild seaweed communities

The checklist of seaweeds in Malaysia is being updated by new collections and the discovery of new species. In 2013 and 2014, four new species, *Mesospora elongata* Poong, Lim & Phang 2013, *Pterocladiella phangiae* Jelveh, Lim & Maggs 2013, *Pterocladiella megasporangia* Jelveh, Lim & Phang 2013 and *Kappaphycus malesianus* Tan, Lim & Phang 2014, were described. The spatial distribution of Malaysian seaweeds based on the checklist of Phang 2006, was mapped using GIS (Du et al. 2008) (Fig. 1). Most of the seaweeds were collected from shallow corals reefs, mangroves and rocky shores. The deeper habitats especially the waters of Sabah and Sarawak, has been less sampled.

Data on the abundance of the seaweeds is greatly lacking, as only few locations have been surveyed. An example of a natural seaweed bed that has been regularly surveyed is the fringing coral reefs of Port Dickson, west coast Peninsular Malaysia. The table below has been updated with new standing biomass data for the reef flat at Port Dickson, where 69 species dominated by *Sargassum*, *Turbinaria*, *Padina* and *Caulerpa* according to seasons, have been reported.

reported	Productivity(Growth rates)	References
Eucheuma /Kappaphycus spp	0.15 kg/day	Phang 2006
Gracilaria changii	3.3 – 8.4 %/day	Phang et al. 1996
Gracilaria changii	58 – 98 $g \cdot m^{-2}$	Phang & Maheswary, 1989
Sargassum binderi	81 g dw /m^2 (maximum standing biomass)	Wong et al. 2004
Sargassum baccularia	65 g dw /m^2 (maximum standing biomass)	Wong et al. 2004
Mixed biomass at a fringing coral reef, Port Dickson	16.9 – 103.5 $g \cdot m^{-2}$ (standing biomass)	Phang, 1995
Sargassum binderi, dominant on the coral reef flat, Port Dickson, west coast Peninsular Malaysia	426.15±181.33 g DW m^{-2} (standing biomass) during the September 2010 survey	Keng et al., 2013

Based on the data from the reef flat seaweed community at Port Dickson, about 128 $g \cdot m^{-2}$ carbon is stored in the standing biomass.

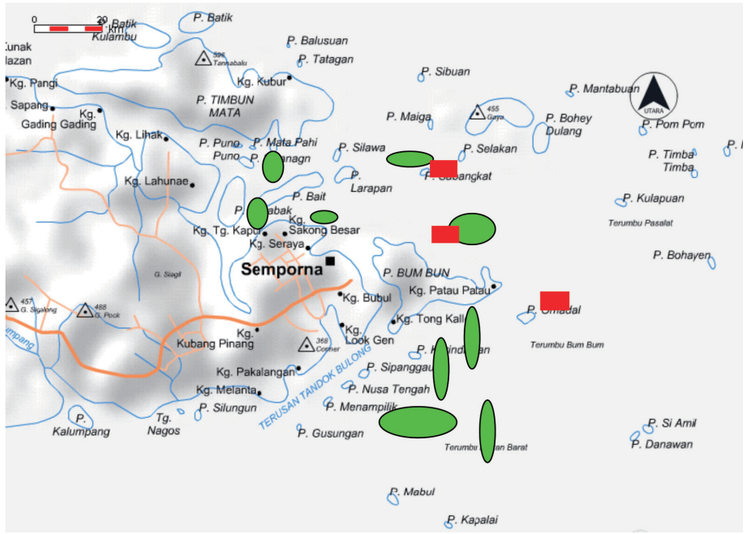
3. Estimate carbon stored and sequestered in seaweeds on the artificial reefs

There are no artificial seaweed reefs n Malaysia although artificial coral reefs have been established in Malaysia. However there is no focused survey of the seaweed species colonizing these reefs.

4. Estimate carbon stored and sequestered in aquacultured seaweed beds

A report from the Fisheries Department of Sabah (16 December 2013) revealed that the seaweed production in 2013 was 26,943 MT dry weight, meeting the target of 26,000MT. An initiative to increase the commercialisation of seaweed farming in Sabah resulted in 170 farmers cultivating over an area of 550 ha with a target of 850 MT/ha production. These farms are located in Semporna and Tawau, Sabah. Other farms are located at Lahad Datu, Kunak, Banggi and Kudat. The seaweeds commercially farmed for carrageenan belong to the genera *Kappaphycus* Doty and *Eucheuma* J. Agardh. The area under seaweed farming in Sabah is 8000 ha. In 2013 the seaweed production in the farms ranged from 1.93 to 3.28 MT/ha/yr (Sabah Fisheries Dept., 2014). The target is 13 MT/ha/yr. In the EPP initiative, a mini-estate system, coordinated by the University Sabah Malaysia, will also target 150,000 metric tonnes production in 2020. With an additional 3,000 ha being designated for the mini estates, to be focussed around Pulau Omadal, Pulau Bum Bum and Pulau Sebangkit in Semporna, the total area for seaweed farming will amount to 11,000 ha. Another 40,000 hectares were also identified for the sector, which is expected to generate 150,000 tonnes of seaweed annually.

4.1. Distribution and acreage of seaweed aquaculture beds



The seaweeds farms in Sabah together with additional areas for expansion are shown below.

4.2 Estimate of the seaweed biomass and production

4.2.1 *Kappaphycus* and *Eucheuma*

In Malaysia, only species of *Kappaphycus* and *Eucheuma* are commercially cultivated. In the recently published "Guide to *Kappaphycus* and *Eucheuma* seaweeds in Malaysia" (Tan et al., 2014a), 6 local varieties of *Kappaphycus alvarezii*, 2 varieties of *K. striatus* and 2 varieties of *Eucheuma* were recorded. A new species *Kappaphycus malesianus* Tan, Lim & Phang was recently described (Tan et al. 2014b). This species is known locally as *Aring-aring* and is grown together with *K. alvarezii*; both species produce kappa-carrageenan. *Kappaphycus alvarezii* is cultured for production of kappa-carrageenan while *Eucheuma denticulatum* is gown for iota-carrageenan.

Presently the total area under seaweed farming is 8000 ha. The production in Sabah was reported to be: 1.70 MT/ha for 2009
2.63 MT/ha for 2010
2.78 MT/ha for 2011
2.57 MT/ha for 2012
1.93 to 3.28 MT/ha/yr for 2013 (Fisheries Dept. Sabah 2014 report).

The total seaweed production was 24,355.2 MT dry weight for 2013. At an average selling price of USD 1.10 per kg DW, the revenue generated from the seaweed industry was USD 26.8 million for 2013.

In an evaluation of potential bioethanol production from the Sabah seaweeds, Goh and Lee (2010) estimated that based on optimal production of seaweed biomass in Sabah, the production of third generation biofuel

(TGB) bioethanol may be 241 ktonnes per year. Use of seaweed biomass as feedstock for biofuel contributes best to the role of seaweed as a carbon sink. Based on carbon content of 30% in dry biomass of seaweed, the seaweeds farms in Sabah "removed" 7.31 MT (2013) of carbon from the sea, the final fate of the carbon is important. The production and use of the seaweed may be a carbon neutral at best, although if it is used for biofuel production, it may be carbon negative and therefore may contribute to carbon reduction. This can then provide the basis of a carbon credit system, which to date has not be seriously proposed.

C.S. Goh, K.T. Lee / Renewable and Sustainable Energy Reviews 14 (2010) 842–848

Table 1
Annual production capacity of TGB in Semporna, Sabah.

Component	Value	Unit
Unit of cultivation	–	line
Area of 1 unit of cultivation	5	m^2/line
Wet seaweed yield	30	kg/line/harvest
Moisture content	90	%
Dry seaweed yield	3	kg/line/harvest
Number of harvest	5	harvests/year
Dry seaweed production rate	3	kg/m^2/year
Carbohydrates yield	0.7	kg/kg dry seaweed
Galactose content in carbohydrates	56.2	%
Galactose yield	0.3934	kg/kg dry seaweed
Galactose production rate	1.18	kg/m^2/year
Theoretical yield	51.1	%
Fermentation efficiency	0.39	%
Area available	102,413	ha
Annual dry seaweed yield	3,072	ktonnes
Annual galactose yield	1,209	ktonnes
Annual TGB yield	241	ktonnes
Net calorific value for ethanol	27	GJ/tonnes
Energy produced	6.50	$10^6 \times$ GJ

5. Other mitigation and adaptation measures

5.1 Sea level rise

Sea level rise due to climate change has been estimated to be around 1.3mm per year for Tg. Piai, Johor, west coast Peninsular Malaysia. At Sandakan, Sabah, east Malaysia, the rate of sea level rise is 3.45 mm/year. This is projected to result in a loss of fisheries production of USD100 million based on 20% loss of mangrove which will result in a loss of about 70,000 tonnes of prawn production. The Department of Irrigation and Drainage (DID) of Malaysia (2006) reported that 1414.5 km, 29% of Malaysian shorelines face erosion impacts. The area of mangrove forests continues to decline at a rate of 1% per year. To address this, the Coastal Processes Research group in the Institute of Ocean and Earth Sciences (IOES), University of Malaya has developed eco-engineering technologies, combining engineering structures and mangrove stands to protect coastlines from erosion and sea level rise.

5.2 Ocean acidification

There has been no major study on this. However, in the OES, University of Malaya, there is a project on "Carbon analysis of sediment and vegetation in selected mangrove habitats": The objectives of this study are to assess carbon content of some selected mangrove sapling and sediment/soil along with environmental parameters (e.g., salinity, pH, soil texture and electrical conductivity) of the sediment/soil. Mangroves serve as important Carbon sink; however, there is little data of carbon content. The group has interest in effect of climate change on the mangrove ecosystem. The results generated will assist in the efforts for implementing conservation of the mangroves which are very important for sustainability of both ecological and human ecosystems.

5.3. Anthropogenic effect on coastal ecosystem

Malaysia has established the Marine Parks to manage and protect marine biodiversity and the ecosystems. The areas designated as Marine Parks are shown in the following table.

	Marine Protected Areas	Gazettes	No. MPAs
1	Peninsular Malaysia	Marine Parks Order of 1994, Fisheries Act	42
2	Sabah	Sabah Parks Enactment (1984) Amended 2002	8
3	Sarawak	The National Park and Reserve Ordinance	3
			53(2318 ㎢)

Malaysia is also participating in the Bay of Bengal Large Marine Ecosystem Programme and the Sulu Celebes Large Marine Ecosystem Programme. Malaysia also plays a big role in the Coral Triangle Initiative (CTI), which is the centre of seaweed cultivation in the region.

The survey from 2007 to 2011 by Reef Check Malaysia (Julian Hyde, SCS 2012), showed that anthropogenic impacts had most influence on the coral reef ecosystem. Nutrient indicator algae were used as one parameter to indicate health of the corals. Results are shown in the following table.

Year	% cover of Nutrient indicator Algae in reefs in whole of Malaysia	% cover of Nutrient indicator Algae in reefs of Tioman Island, east coast Peninsular Malaysia
2007	11.13	3.57
2008	6.62	3.23
2009	4.83	1.20
2010	4.35	4.69
2011	4.34	2.73

There appears to be a decrease in the relative abundance of nutrient indicator algae (seaweeds) in the coral reefs from 2007 till 2011. This may be an indication of the successful management of the sites where the reefs are found, namely the Marine Park islands.

6. New research projects undertaken

In 2015, a new research project was initiated at the University of Malay, in the form of a 5-year Grand Challenge Programme consisting of 3 sub-projects. The summary of the programme is as follows:
Global seaweed trade and industry is worth USD 6.4 billion with production of 23.4 million MT seaweeds. However, after 35 years of seaweed farming and the introduction of an NKEA based on Seaweeds, the Malaysian seaweed industry is still in its infancy stage. Therefore, new technologies for optimal onshore and offshore cultivation is essential to push the seaweed industry forward. The cultivation of seaweeds represent a renewable and sustainable agro-industrial system, have no conflict with food crops on arable land, and can reduce CO_2 through photosynthesis. In order to create a higher market value of this seaweed, it is important

to convert this seaweed feedstock to high value-added products like “green battery” and agarose. The socio-economic impact from the seaweed cultivation to development of high value-added products, on selected coastal communities, will be evaluated.

7. Concluding Remarks

Although there is no nation-wide programme to utilize seaweeds as a carbon sink, research is being conducted at the various universities. The research focus on:

i) Taxnomy and phylogenetics of seaweeds, especially commercial species like *Kappaphycus* and *Eucheuma*, *Sargassum*, *Gracilaria*, etc.
ii) Mariculture, micropropagation, tissue and protoplast culture of commercial species.
iii) Products from seaweeds: biopharmaceuticals, phycocolloids, food, feed, fertilizer, biofuel.
iv) Growth, response and adaptation of seaweeds to climate change.
v) Ecology of seaweeds.

The IOES successfully completed the 3rd SEASTax Workshop on seaweed taxonomy at the Bachok Marine Research Station. About 26 participants including five lecturers (Prof. John West for mangrove red algae, Prof. Sung Min Boo for Galaxauraceae, Prof. Showe-Mei Lin for *Gracilaria* & *Hydropuntia*, Prof. Anicia Hurtado for culture of seaweeds, Prof. Phang Siew-Moi for *Halimeda*) participated. Participants came from nine countries, Taiwan, Korea, Philippines, Thailand, Vietnam, Indonesia, Singapore, Australia and Malaysia. The young phycologists worked together on specimens that they brought from their respective countries, with the mentors. The results will be published as the 3rd SEASTax Monograph, and will add onto the database of marine algae in the region.

As stated in our previous report, the following areas should be adopted for consideration by the Southeast Asian countries in a joint initiative to use seaweeds as potential carbon sinks.

1. Life cycle analysis of the main seaweed species cultivated in Asia, namely *Kappaphycus alvarezii*(SE Asia). Have a basic carbon budget analysis for the life cycle starting from seed production → Planting → harvesting → processing → i) for food/food products; ii) carrageenan/alginate; bioethanol, etc.
2. Comparison between biomass production/productivity/photosynthesis rates between natural seaweed populations and farmed seaweeds.
3. The best way to use seaweed biomass is to convert it to bioethanol to replace fossil fuel. However, we need to carry out the life cycle analysis.
4. Cost-benefit analysis of the seaweed production and downstream processes should be conducted.
5. Seaweed resource and ecosystem benefits valuation should also be conducted.

8. Bibliography

1. Azhar Hussin, Chong V C, Md Yusoff Musa, Mohd Sofian Azirun, Rosli Hashim & Phang Siew Moi (2005) Scientific Expedition to Langkawi by University of Malaya Maritime Research Centre. Malaysian Journal of Science Vol. 24 (Langkawi Special Issue) ISSN1394-3065.
2. Du Hai Lian, Jillian Ooi Lean Sim, Rosmadi Fauzi & Phang Siew Moi. 2008. Spatial patterns of seaweed distribution in Malaysia using GIS. Proc. of SPIE Vol. 7145, 71452H · © 2008 SPIE · CCC code: 0277-786X/08/$18 · doi: 10.1117/12.813073
3. Goh CS & KT Lee (2010). A visionary and conceptual macroalgae-based third-generation bioethanol (TGB) biorefinery I Sabah, Malaysia as an underlay for renewable and sustainable development. Renewable and Sustainable Energy Reviews 14: 842-848
4. Fiona Seh-Lin Keng, Siew-Moi Phang, Noorsaadah Abd Rahman, Emma C. Leedham, Claire Hughes, Andrew D. Robinson, Neil R. P. Harris, John A. Pyle and William T. Sturges (2013) Volatile halocarbon emissions by three tropical brown seaweeds under different irradiances. J. Appl Phycol. 25: 1377–1386
5. Lim PE & Phang SM. (2012). Seaweeds on fish cages at Pulau Ketam. In: A. Sasekumar & Chong VC (eds). Mangrove and Coastal Enviroment. Institute of Ocean and Earth Sciences, University of Malaya Monograph Series 14. p. 205-213.
6. Lim PE, Tan J, Adibi R and Phang SM (2014) A Guide to *Kappaphycus* and *Euchema* Seaweeds in Malaysia. Institute of Ocean and EarthScience (IOES) ISBN: 978-983-100-742-6
7. Phang S.M. 1995.Distribution and abundance of marine algae on the coral reef flats at Cape Rachado, Peninsular Malaysia. Malaysian J. Sci. 16A: 23-32.
8. Phang SM & Maheswary Vellupillai. 1990. Phycocolloid content of some Malaysian seaweeds. Proceedings of the 12th Ann. Sem. M'sian Soc. Marine Sciences (eds.Phang et al.): 65-78
9. Phang SM, Shafeei Shaharuddin, Hashim Noraishah & Sasekumar A. 1996. Studies on *Gracilaria changii* (Gracilariales, Rhodophyta) from Malaysian mangroves. Hydrobiologia 327: 347-352
10. Phang SM, Wong CL, Lim PE, Y HY & Chan CX. 2005 Seaweed Diversity of Langkawi with emphasis on Northeast Langkawi. Malaysian J. Science 24: 77-94
11. Phang SM. 2006. Seaweed Resources in Malaysia: Current status and future prospects. Aquatic Ecosystem Health & Management 9(2): 185-202
12. Phang SM, Wong CL, Lim PE, Ooi JLS, Gan SY, Melor Ismail, Yeong HY & Emienour Muzalina Mustafa. 2007. Seaweed Diversity in Malaysia. In: Chua LSL, Kirton LG & Saw LG (eds) Status of Biological Diversity in Malaysia and Threat Assessment of Plant Species in Malaysia. Forest Research Institute Malaysia. p. 185-210
13. Phang SM, Lim PE and Yeong HY (2010). Malaysian Seaweed Resources in the South China Sea and their potential economic and ecological applications. In: Lim PE, Hussin H., Idid M. R. & Mokhtar N. A (eds) The South China Sea: Sustaining ocean productivities, maritime communities and the climate. Institute of Ocean and Earth Sciences, University of Malaya Monograph Series 11. p87 -109.
14. Phang SM, and Lim PE (eds). 2013. Taxonomy of Southeast Asian Seaweeds II. Institute of Ocean and Earth Sciences, University of Malaya Monograph Series 15. University of Malaya Press, Kuala Lumpur. ISBN: 978-983-100-687-0
15. Phang SM, Lewmanomont K, Lim PE (eds).2008. Taxonomy of Southeast Asian Seaweeds. Institute of Ocean and Earth Sciences, University of Malaya Monograph Series 2. ISBN: 978-967-5148-13-2.
16. Phang SM, AF Amri, Ooi LSJ Mydin H A J (eds) 2008. Natural history of The Pulau Tioman Group of Islands. Institute od Ocean and Earth Sciences, University of Malaya Monograph Series 1. 292pp. ISBN: 978-983-9576-35-1
17. Phang SM, A Hussin, Chong VC, R Hashim & S A Alias (eds). 2007. Gems in the Straits of Malacca. The Natural History of Pulau Jarak and Pulau Perak. University of Malaya Maritime Research Centre. 54pp. ISBN 978-983-42305-0-0
18. Phang SM, Critchley AT & Ang PO Jr. 2006. Advances in Seaweed Cultivation and Utilisation in Asia. 177 pp. University of Malaya Maritime Research Centre. ISBN 983-9576-30-5
19. Wong CL, & Phang SM. 2004. Biomass Production of Two *Sargassum* species at Cape Rachado, Malaysia. Hydrobiologia 173: 79-88

Institute of Ocean and Earth Sciences (IOES)

The Institute of Ocean and Earth Sciences (IOES) was established in the University of Malaya in 2003 as the University of Malaya Maritime Research Centre (UMMReC) to coordinate and lead all research activities, training and consultancies in marine and maritime research at the University of Malaya. In 2008, based on its achievements, UMMReC was upgraded to the present Institute of Ocean and Earth Sciences (IOES). In 2009, IOES was recognised as a Centre of Excellence (CoE) under the National Oceanography Directorate (NOD), Ministry of Science, Technology and Innovation (MOSTI), Malaysia. In October 2014, the IOES was awarded the prestigious High Institution Centre of Excellence (HICoE) by the Ministry of Education Malaysia, in recognition of its leadership in the niche area of "Air-Ocean-Land Interactions". The IOES addresses MOE's priority area of Environment and Climate.

The Institute of Ocean and Earth Sciences (IOES), conducts research and undertakes education and technology development in ocean and earth sciences. The research mission of this institute is to achieve international excellence, lead in national and regional research programmes, and to be a leading academic centre for ocean and earth sciences in the region. The function of the Institute is three-pronged: Research, Academic Training and Technology Development, which it carries out through its members helming seven Research Units, namely

i) Marine Biodiversity and Ecosystem Studies Research Unit
ii) Marine Biotechnology Research Unit
iii) Marine Connectivity Research Unit
iv) Air-Ocean-Land Interaction Studies and Climate Change Research Unit
v) Coastal Processes Studies and Coastal Engineering Research Unit
vi) Maritime Culture & Geopolitics Research Unit
vii) Maritime Law and Policy Research Unit

The uniqueness of IOES lies in its multidisciplinary team of distinguished researchers who are leading scientists in the areas of mangrove ecology, algae biotechnology, coastal eco-engineering, air-ocean interaction and climate change, maritime law and maritime culture. In the IOES, the blend of natural scientists and social scientists provide a formidable team to respond to both scientific and socio-economic issues confronting the coastal and maritime systems.

The IOES Bachok Marine Research Station (BMRS) strategically located at Kelantan and facing the South China Sea, is equipped to support research in marine science, oceanography and atmospheric science. It also serves serve as a testing ground for technologies developed for coastal protection, novel aquaculture, as well as a training ground for aspiring local and foreign marine scientists. The IOES collaborates with several marine and oceanographic institutions including First Institute of Oceanography; Third Institute of Oceanography; Guangzhou Institute of Geochemistry, Chinese Academy of Sciences; The State Laboratory of Marine Environmental Science, Xiamen University; University of Cambridge; University of East Anglia; Chungnam National University; Ihna University; National Taiwan Ocean University; Academia Sinica; British Antarctic Survey; University of Melbourne; University of British Columbia; Uppsala University, etc.

Contact us at:
Professor Dr Siew Moi Phang, Director, Institute of Ocean and Earth Sciences (IOES), University of Malaya. • E-mail: phang@um.edu.my

Institute of Ocean and Earth Sciences (IOES), C308, Institute of Graduate Studies Building, University of Malaya, 50603 Kuala Lumpur, MALAYSIA.
• Tel: (+603) 7967 4640/ 6995 • Fax: (+603) 79676994 • E-mail: admin.ioes.um.edu.my
• http://www.ioes.um.edu.my

The Intended Nationally Determined Contribution (INDC) of Vietnam

Dang Diem Hong

Institute of Biotechnology, Vietnam Academy of Science and Technology

Viet Nam is one of the countries severely affected by climate change and its related disasters. The Mekong Delta is one of the deltas in the world most susceptible and vulnerable to sea level rise. Climate change adaptation is vital for Viet Nam and is regarded by the Government as one of the priority tasks to reduce the vulnerability level. Over the past 50 years, the average temperature in Viet Nam has increased by approximately 0.5°C and the sea level has risen by about 20cm. Extreme climate events have increased both in frequency and intensity.

Viet Nam is willing to respond to climate change, which is demonstrated by the range of national policies and concrete greenhouse gas (GHG) mitigation and climate change adaptation measures that have been undertaken throughout the past decade, funded primarily by domestic financial resources. Additionally, Viet Nam supports achieving a legal agreement with the participation of all Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in order to keep the global average atmospheric temperature increase at below 2˚C.

Viet Nam's INDC includes mitigation and an adaptation component. The mitigation component includes both unconditional and conditional contributions. The unconditional contributions are measures that will be implemented using domestic resources, while the conditional contributions are measures that could be implemented if new and additional international financial support, technology transfer and capacity building are received. With domestic resources GHG emissions will be reduced by 8% by 2030 compared to the Business as Usual scenario (BAU). The above-mentioned 8% contribution could be increased to 25% if international support is received through bilateral and multilateral cooperation, as well as through the implementation of new mechanisms under the Global Climate Agreement, in which emission intensity per unit of GDP will be reduced by 30% compared to 2010 levels.

The adaptation component describes the climate change adaptation actions that are currently being implemented. It also identifies adaptation gaps in terms of institutional and policy arrangements, financing, human resource capacity and technology and prioritized adaptation measures for the 2021-2030 period.

The National Climate Change Strategy has identified that priorities are food, energy, water and social security; poverty reduction; gender equality; public health; livelihood improvements and the protection of natural resources. Through INDC, Viet Nam can communicate current and future climate change response.

Adaptation to climate change will help Viet Nam increases its resilience to climate change and can sometimes also contribute to GHG emissions mitigation. The cost of adaptation is estimated to exceed 3- 5% of GDP by 2030. The shortage of capacities and resources for climate change adaptation measures are major challenges for Viet Nam.

Carbon can be stored in marine organisms such as phytoplankton, seaweeds, seagrasses, and coral reefs in the ocean ecosystems. Seaweeds can be used as a global carbon sink; have potential to drawdown anthropogenic CO_2 because of their high biomass and primary productivity; longer turnover time compared with phytoplankton. The role of seaweed/microalgae blue carbon and adaptation measure in Vietnam will become significant.

The Message from Dr. Biliana Cicin-Sain, President, Global Ocean Forum

Global Ocean Forum Thanks COP 21 Delegates for All the Efforts to Conclude Historic Paris Agreement and for Laying the Groundwork for Action on Oceans in the Implementation Phas

On behalf of all the ocean partners involved in the climate negotiations, especially in the Oceans Day at COP 21, the Global Ocean Forum (GOF) expresses sincere appreciation to all the COP 21 delegates for reaching consensus on the landmark Paris Agreement and for including new language on oceans in the Paris Agreement. We also commend efforts to bring the ocean and coastal and island peoples issues to the COP 21.

The Paris Agreement, concluded on December 12, 2015

History was made in Le Bourget, a suburb of Paris, on December 12, 2015, in the adoption of the Paris Agreement by 196 Parties (195 countries and the European Union) at the end of the Twenty-first Session of the Conference of the Parties of the UN Framework Convention on Climate Change. The Paris Agreement commits, for the first time, all nations on earth to reduce their rates of greenhouse gas emissions to "well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels," and puts into place a system of monitoring and verification of national emissions, as well as significant guidance and tangible commitments on mitigation, adaptation, financing, and capacity development and technology transfer.

This is a historic agreement, a landmark achievement, marking the common political will of all nations to stem the rise of global warming, and to shift the world from fossil fuel-based economies to economies based on renewable energy. It gives hope and tools to all countries, large and small, poor and rich, that the most disastrous consequences associated with climate change (including floods, droughts, sea level rise, devastating storms) may be averted and controlled. It gives new hope and life for the planet and for our children and grandchildren. As President Hollande of France had noted at the outset of the talks, "We are in a fight for our lives." And, then, as many delegations noted at the end of the talks, "this marks a new path for our planet…we have reached an agreement that will help the world transition to a global low-carbon economy…" (US); "we have reached a fair, flexible, and ambitious agreement that will lead to a carbon-neutral world" (Switzerland); "this is a transformational agreement, a triumph of multilateralism" (Morocco); "this is a marvelous action, balancing world interests with national interests" (China); "…the Agreement represents a new chapter of hope…as Ghandi had noted, 'We should care for the world we will not see' (India); "…for the first time, the interests of the small island developing States (SIDS) were taken into account…and the goal of 1.5 C will keep us alive…" (St Lucia, on behalf of the Caribbean states).

The Paris Agreement includes provisions for:

- Holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change (The previous global goal had been to hold the global average temperature increase to 2 degrees Celsius above pre-industrial levels. The 1.5 degree Celsius goal had long been advocated by the 44 small island developing States, "1.5 to stay alive," referring to the threats of sea level rise, increased floods and storms which could obliterate their homes and nations.)
- A system of national reports by all countries reporting on reductions to emissions and other matters every five years, and a transparent system of accounting and verification, with periodic "global stocktake"
- Financing by developed countries to assist developing countries with respect to both mitigation and adaptation
- Strengthening of capacity development regarding mitigation and adaptation programs, and cooperative action on technology development and transfer
- Averting, minimizing, and addressing human displacement issues related to the adverse impacts of climate change

The Paris Agreement is not perfect, no country delegation was entirely happy with the overall package. But the Paris Agreement lays the foundation to a wholesale transformation of all economies and societies to ensure a livable future.

The Politics

At the start of the negotiations two weeks ago (November 30, 2015), there was great skepticism that the consensus on the Paris Agreement could be achieved. Deep divisions existed among nations, especially on: the target of less than 2 degrees Celsius or 1.5; the extent to which developing countries should have equal or differentiated responsibilities in responding to climate change; the extent to which developed nations should provide financing for adaptation and mitigation, as well as for "loss and damage" incurred by developing nations and SIDS; the extent to which there should be regular, monitored, and transparent reviews of countries' climate pledges.

Country delegates unanimously pointed out the leadership role of France in its management of the negotiations and the central role in building consensus of France's Foreign Minister Laurent Fabius. Among others, the US and EU reportedly also played pivotal roles in the achieving of consensus, as part of the "high ambition coalition"--informally led by Tony de Brum, Foreign Minister of the Marshall Islands, one of the countries most affected by climate change, and including other SIDS countries, and other countries from Africa and Asia.

Oceans at COP 21

Building on the three previous Oceans Days organized by the Global Ocean Forum, the Intergovernmental Oceanographic Commission, UNESCO, with many partner organizations (Copenhagen-UNFCCC COP 15, 2009; Cancun-UNFCCC COP 16, 2010, and Durban-UNFCCC COP 17, 2011), the Oceans Day at COP 21, 4 December 2015, was a high-level event held to:

- Highlight the major climate and oceans issues, with emphasis on the impacts on the most vulnerable peoples and ecosystems, and suggest next steps, both within and outside the UNFCCC framework;
- Foster political leadership and move forward on the major climate and oceans solutions with the engagement of high-level leaders around the world;
- Catalyze and share solutions as part of the global portfolio of actions;
- Mobilize collaboration in the development of a five-year strategic plan on oceans and climate to guide policy and action.

The Oceans Day at COP 21 was organized by 46 partner organizations (including governments, intergovernmental/international organizations, non-governmental organizations/foundations, and academic/scientific institutions) (see full list of partner organizations, Box 1, in the Oceans Day program). The meeting featured high-level leaders from around the world, including 2 heads of state (Palau and Monaco); government ministers and other high-level officials from Australia, European Union, Fiji, France, French Polynesia, Grenada, Indonesia, Japan, Netherlands, Palau, Papua New Guinea, Peru, Portugal, Seychelles, South Africa, Sweden, United Kingdom, and United States; heads of and high level officials from UN agencies and international organizations (UNESCO and IOC/UNESCO, CBD, GEF, FAO, WMO, IMO, IPCC, PIFS, UNEP, SPC, World Bank, Benguela Current Commission, African Union Commission), heads of major civil society and private sector organizations (such as IUCN, TNC, WWF, OPRI-SPF, European Network of Maritime Clusters, Seafish, WON, Ocean and Climate Platform), and leading technical experts (see the program for the Oceans Day at COP 21). Over 400 participants, coming from countries around the world, took part in the event.

Topics presented at Oceans Day included: Addressing the Effects of Climate Change on Oceans and on Coastal and SIDS Populations: The Scientific Evidence, Scenarios and Choices for Decisionmakers; Adaptation and Financing for Adaptation; Mitigation and the Oceans; Financing, Capacity Development, Scientific Monitoring, and Public Education; and Bringing it All Together: A Five-Year Agenda for Action.

The Oceans Day at COP 21 stressed the need for:

- Concluding an ambitious legally binding agreement with stringent reductions in greenhouse gas emissions as essential to avoid disastrous consequences for the ocean and for coastal and island peoples. This was achieved with the Paris Agreement.
- Recognizing the central role of the oceans in regulating climate, and the fact that the ocean will not be able to perform these functions in the future if global warming continues unabated. This work was begun with a new provision in the Preamble to the Paris Agreement, which notes "Noting the importance of ensuring the integrity of all ecosystems, including oceans,…when taking action to address climate change,"
- Targeting financing to address climate change impacts in coastal communities and island states—for adaptation programs, for capacity development, for mitigation efforts to preserve coastal and ocean ecosystems, and for addressing the problems of climate-induced population displacement with equity and justice, This is a work in progress which will continue in the next five years through, in part, the joint efforts of the partner organizations involved in the Oceans Day at COP 21 and an International Working Group on Oceans and Climate coordinated by the Global Ocean Forum and the University of Delaware Mangone Center for Marine Policy.

The Earth Negotiations Bulletin (ENB) has produced an extended report of Oceans Day at COP 21; please see the summary report (pdf/html) and go here for extensive photos of Oceans Day.

In addition to the Oceans Day at COP 21, over 40 other ocean events were held during COP 21, including the Ocean and Climate Forum on December 3, coordinated by the Ocean and Climate Platform. The mobilization of all facets of the oceans community—marine scientists, marine policy experts, civil society groups, international agencies, and government leaders from around the world was unprecedented and bodes well for the continued advancement of the oceans and climate issues in the future.

The efforts to bring the ocean issues into the climate regime, especially the new Paris Agreement, will continue, including with preparations for the Oceans Day at the UNFCCC COP 22 in Marrakech, Morocco, to be held on November 7-18, 2016.

Paris, As Always

Our GOF team stayed in central Paris while at COP 21. The city seems almost back to normal after the brutal attacks of one month ago, although there is a bit less traffic. I had a chance to talk with many people on the street—in cafes, the hotel, taxis… Invariably, they were well informed about climate change and were rooting for a good outcome at COP 21 "pour sauver la planète," to save the planet. This is no doubt due to the many public education efforts on climate change on the part of civil society, the private sector, and the French authorities, including the many efforts of our friends and colleagues in the Ocean and Climate Platform, Nausicaa, and the World Ocean Network.

We should work to do the same in all our countries.

Biliana Cicin-Sain, Global Ocean Forum and University of Delaware

Dr. Biliana Cicin-Sain
President, Global Ocean Forum
Tel: 1-302-831-8086; Fax: 1-302-831-3668 significant.
E-mail: bilianacicin-sain@globaloceans.org
Internet: Global Ocean Forum http://www.globaloceanforum.com

The 3rd Korea-ASEAN International Workshop
- Climate Changes, Seaweed and CO_2 Sequestration -

Ocean Acidification and Seaweed Adaptation

February 20-21, 2016
Pullman Kuala Lumpur Bangsar
Kuala Lumpur, Malaysia

Member

Ik Kyo Chung (Network organizer, Korea)
Grevo S. Gerung (Indonesia)
Dang Diem Hong (Vietnam)
Danilo B. Largo (Philippine)
Jin Ae Lee (Korea)
Phaik Eem Lim (Malaysia)
Siew Moi Phang (Malaysia)
Calvyn Sondak (Indonesia)

We thank to sponsors and partner organizations:

Sponsors

The National Research Foundation of Korea
Pusan National University (PNU) & Marine Research Institute (MRI)
Institute of Ocean and Earth Sciences (IOES), University of Malaya, Malaysia

ASEAN partner organizations

Institute of Biotechnology (IBT), Vietnamese Academy of Science and Technology (VAST), Vietnam
Faculty of Fisheries and Marine Science, Sam Ratulangi University, Indonesia
University of San Carlos, Philippine

Contact: Ik Kyo Chung (Dept. Oceanography, Pusan Nat'l Univ.) ikchung@pusan.ac.kr

Workshop/Symposium schedule

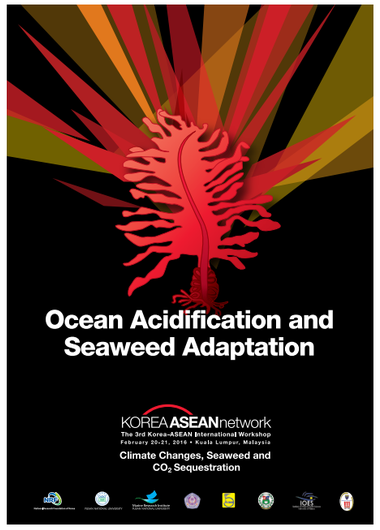
Friday, February 19

Arrival (Check-in)
Afternoon Pullman Kuala Lumpur Bangsar
No. 1 Jalan Pantai Jaya Tower 3, 59200 Kuala Lumpur, Malaysia
Phone: +60 3-2298 1888

Saturday, February 20

09:30 - 10:30 **Korean-ASEAN Network business meeting**
Pullman Kuala Lumpur Bangsar Studio 05 Level 03
Ik Kyo Chung (Korea, Network organizer)
Hui Yin Yeong (Malaysia, Local Organizer)
Grevo S. Gerung (Indonesia) Dang Diem Hong (Vietnam)
Danilo B. Largo (Philippine) Jin Ae Lee (Korea)
Phaik Eem Lim (Malaysia) Siew Moi Phang (Malaysia)
Calvyn Sondak (Indonesia)

Mie Ae Kang, Jin Woo Kang (Korea, Network Assistants)
Coordinators: Hui Yin Yeong (Malaysia) & Ik Kyo Chung (Korea)



10:30 - 10:50 Refreshment (Studio 05 Level 03 Foyer)
10:50 – 11:50 **Korean-ASEAN Network business meeting (cont.)**
11:50 - 13:15 Lunch (LINK Restaurant Level G)

Hosted by Network

Symposium/Workshop

Pullman Kuala Lumpur Bangsar 05 Level 03
13:15 - 13:30 **Registration** (Studio 05 Level 03 Foyer)
13:30 - 13:45 **Welcome & Opening ceremony** (Studio 05 Level 03)

Moderator Jin Ae Lee (Korea)

Korea-ASEAN Network (Ik Kyo Chung)
Institute of Ocean and Earth Sciences (IOES), Siew Moi Phang (Malaysia)
Introduction of participants
13:45 - 13:50 **Group Photo**
13:50 - 15:20 Session **1 "Ocean Acidification"**

Chairperson Danilo B. Largo (Philippine)

Invited Lecture: The Impact of Ocean Acidification on Carbon Storage and Sequestration in Corals: A Global and Malaysian Context

Professor Dr Mohamad Pauzi Zakaria (Institute of Ocean and Earth Sciences, University of Malaya)
Q & A and Round Table Discussion

Moderators Siew Moi Phang (Malaysia) & Jin Ae Lee (Korea)

15:20 - 15:40 Break and refreshment (Studio 05 Level 03 Foyer)
15:40 - 17:30 **Session 2 "Climate Change Adaptation and Seaweeds"**
Introduction of the Paris Agreement and Adaptation

Grevo S. Gerung (Indonesia) & Ik Kyo Chung (Korea)

Introduction of the Intended Nationally Determined Contributions (INDC)

Phaik Eem Lim (Malaysia) & Dang Diem Hong (Vietnam)

The Seaweed Aquaculture Beds and Adaptation

Calvyn Sondak (Indonesia) & Danilo B. Largo (Philippine)

Round Table Discussion

Moderators Siew Moi Phang (Malaysia) & Jin Ae Lee (Korea)

Sunday, February 21

09:00 - 10:30 **Post Korean-ASEAN Network business meeting and departure**
Ik Kyo Chung (Korea, Network organizer)
Hui Yin Yeong (Malaysia, Local Organizer)
Grevo S. Gerung (Indonesia) Dang Diem Hong (Vietnam)
Danilo B. Largo (Philippine) Jin Ae Lee (Korea)
Phaik Eem Lim (Malaysia) Siew Moi Phang (Malaysia)
Calvyn Sondak (Indonesia)
Mie Ae Kang, Jin Woo Kang (Korea, Network Assistants)

Coordinators: Hui Yin Yeong (Malaysia) & Ik Kyo Chung (Korea)

UPCOMING EVENTS

1) The 7th World Fisheries Congress

The city of Busan in Korea is going to host the 7th World Fisheries Congress under the theme "Challenge to Sustainable Fisheries and Safe Seafoods" from May 23 to 27 in 2016 at BEXCO. There are 38 sessions concerning to the following topics: Aquaculture, Bycatch, Climate Change and fisheries, Fish Biology, Fisheries Assessment, Food Science, Hydropower and Energy, Management and Social-Ecological Systems, New Techniques and Technology, and Stock Assessment. As you all know Busan held the successful WAS meeting in 2008, we cordially invite you to Busan, the city of Ocean and Fisheries. See you soon Busan again at the WFC 2016.
http://www.wfc2016.or.kr/english/01_introduce/01_introduce.asp

2) The International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), through the Mediterranean Agronomic Institute of Zaragoza (IAMZ), together with the Research University Institute Ecoaqua of the University of Las Palmas de Gran Canaria(ULPGC), organize a new edition of the international course on "Marine Algae Culture: Techniques, Uses and Development Perspective at ULPGC (Spain), 13-17 June 2016.

Time	Monday 13	Tuesday 14	Wednesday 15	Thursday 16	Friday 17
9:00-10:00	Opening	3.1.1.Basic aspects of seaweed cultivation. Production and markets **T. Chopin**	3.3.2. Case study: Integrated multi-trophic aquaculture of fish/seaweed/mollucs in Canada and the Canary Islands **R. Haroun, T. Chopin**	4.2. Microalgae applications: Ingredients for functional foods and nutraceuticals **V. Kiron, M. Barbosa**	5.3. Seaweeds as a CO_2 sink **Ik Kyo Chung**
10:00-11:00	1. Biodiversity of photo-synthesizing aquatic organisms and main groups of cultured marine algae - **R. Haroun**	3.1.2.Production seaweds: Open sea systems **Ik Kyo Chung**		4.3. Microalgae applications: Pharmaceuticals, cosmetics, agrochemicals, pigments, others.- **M. Barbosa**	5.4. Social aspects of integrated multi-trophic aquaculture systems **T. Chopin**
11:30-12:30	2. Photobiology and ecophysiology of algae **F. López Figueroa**	3.1.3. Production seaweds: Ponds and tanks **Ik Kyo Chung**	3.3.1. Case study: Microalgae culture in aquaculture **V. Kiron**	5.1. Seaweeds applications: Human food and aquaculture feeds **A. Critchley**	6. Future applications: biofuels, space systems and genetic expression systems **R. Robaina**
12:30-13:30		3.1.4. Production seaweds: Harvesting and processing **Ik Kyo Chung**	4.1.Microalgae applications: Aquaculture feeds **V. Kiron**	5.2. Seaweeds applications: Phycocolloids and other compounds of interest as pharmaceuticals, cosmetics, etc. **A. Critchley**	
15:00-16:00	7.1.Identifying species **J.L. Gómez-Pinchetti, R. Haroun**	3.2. Production microalgas: Open systems Fotobiorreactores **M. Barbosa**	7.4. Assessing seaweed culture dynamics **R. Haroun, F. López Figueroa**	5.2. Seaweeds applications: Phycocolloids and other compounds of interest as pharmaceuticals, cosmetics, etc. **A. Critchley**	8. Discussion on prospects for algae culture and commercial applications in participants' countries **R. Haroun, Ik Kyo Chung, T. Chopin, R. Robaina, J.L. Gómez-Pinchetti, V. Kiron, M. Barbosa, A. Critchley**
16:00-17:00	7.2. Measuring ecophysiological parameters **F. López Figueroa, R. Haroun**		7.5. Determining population dynamics in microalgae cultures **J.L. Gómez-Pinchetti**	7.6. Monitoring, collection and processing **J.L. Gómez-Pinchetti**	
17:00-18:00		7.3. Introducing microalgae and seaweed culture techniques **J.L. Gómez-Pinchetti, R. Haroun**			
18:00-19:00					

3) International Seaweed Symposium 2016, June 19 - 24, 2016 in Copenhagen (www.iss-2016.org)

4) We are pleased to announce that the 8th Asia-Pacific Phycological Forum (APPF 2017) will be held in October 2017 at Kuala Lumpur. The APPF is held every three years under the auspices of Asia Pacific Phycological Association (APPA). The objectives of APPF 2017 are to:

- To advance phycology in the Asian Pacific region
- To serve as the venue for the exchange of information related to phycology
- To promote international cooperation among phycologists and phycological societies in the Asian Pacific region

The Forum will cover current topics on algae research, which include Algae Biofuel, Bio-products of Algae, Algae and Climate Change, Marine Bio-active Compounds, Algal Taxonomy and Phylogeny, Algae and Environmental Biology. In addition to present and learning the state of the art of algae research, and the opportunities to establish links with the algae industry, especially in the Asia-Pacific region; the participants may also experience the whole of Asia in one single destination in Malaysia. With its vibrant blend of Malay, Chinese, Indian and indigenous cultures, reflected in its diversity of food, language, architecture, festivals and lifestyle. Malaysia is also a land of scenic beauty and blessed with beautiful natural landscape. We would like to welcome your full participant at the upcoming APPF 2017, for more information kindly contact:

Lim, Phaik Eem, PhD
Associate Professor & Head of Marine Biotechnology Unit
Institute of Ocean and Earth Sciences (IOES)
University of Malaya, 50603 Kuala Lumpur, Malaysia
phaikeem@um.edu.my

5) The 23rd International Seaweed Symposium, April 21-26, 2019, International Convention Center Jeju, Korea

The members of Working Group for the Asian Network for Using Algae as a CO_2 Sink, Asian Pacific Phycological Association

Prof. Sung Min Boo
President of the Asian Pacific Phycological Association

Prof. John Beardall, Monash University, Victoria 380, AUSTRALIA
Prof. Zhengyu Hu, Chinese Academy of Sciences, Wuhan 430072, CHINA
Prof. Put O. Ang, Jr., The Chinese University of Hong Kong, Hong Kong SAR, CHINA
Prof. Dinabandhu Sahoo, University of Delhi, Delhi 110007, INDIA
Prof. Grevo S. Gerung, Sam Ratulangi University, Manado 95115, INDONESIA
Prof. Hiroshi Kawai, Kobe University, Kobe 657-850, JAPAN
Prof. Ik Kyo Chung, Pusan National University, Pusan 609-735, KOREA
Prof. Jin Ae Lee, Inje University, Gimhae 621-749, KOREA
Prof. Siew-Moi Phang, University of Malaya, Kuala Lumpur 50603, MALAYSIA
Prof. Charles S. Vairappan, University of Malaysia Sabah, Sabah 88999, MALAYSIA
Dr. Wendy A. Nelson, NIWA, Wellington 6241, NEW ZEALAND
Prof. Danilo Largo, University of San Carlos, Cebu City 6000, PHILIPPINES
Prof. Yuwadee Peerapornpisal, Chiang Mai University, Chiang Mai 50200, THAILAND
Dr. Dang Diem Hong, Vietnamese Academy of Science & Technology, Hanoi 10000, VIETNAM

CONTACT :
Prof. Sung Min Boo

President
Asian Pacific Phycological Association

Chungnam National University
Taejeon 305-850, Korea
smboo@cnu.ac.kr

Prof. Jin Ae Lee

Editor & Secretary
The Asian Network for Using Algae as a CO_2 Sink
Asian Pacific Phycological Association

School of Environmental Science & Engineering
Inje University
Gimhae 621-749, KOREA
envjal@inje.ac.kr