PROCEEDINGS

The
National
Seagrass-Mangrove
Bioshield
Conference

APN

Marine Science Institute CS
University of the Philippines
Diliman, QC, 26-27 May 2016

FOREWORD

The Marine Science Institute CS of the University of the Philippines & the Department of Environmental Science of SOSE, Ateneo de Manila University are jointly holding this conference, entitled, *The National Seagrass-Mangrove Bioshield Conference* (NSMBC). With funds from the Asia-Pacific Network for Global Change Research (APN), the Department of Science & Technology, support from the National Research Council of the Philippines, & other partners, the conference has the following objectives:
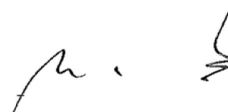
1. To consolidate local & current data & information on the efficacy of seagrass & mangroves in mitigating impacts of climate variability & biodiversity loss; &
2. To provide a stage for the formulation of a national blue carbon strategy focused on conserving the 'bioshield' functions of these 'blue carbon' ecosystems.

The conference features **Welcome and Opening Addresses** from key officers of the above institutions, **Plenaries** by renowned scientists providing the atmosphere for pertinent discussions, and **Oral and Poster presentations** representing relevant updates on the subject matter from various sectors (e.g. academe, government, non-government, the communities, the youth, funding institutions). The presentations fall under four **Sessions** aligned with the themes. Introduced by 15-minute presentations by experts from different fields, **Panel Discussions** cap these sessions. These presentations focus on innovative, pragmatic nature-based solutions to coastal issues, in the context of the specific lines of expertise of the experts. The discussion topics are: "Sustaining the services of seagrasses and mangroves" and "Developing the framework of a National Blue Carbon Strategy". This Book of Abstracts, in addition to the technical components, gives a brief account of the conference.

Having met the objectives, the outcomes of the conference intend to help improve and enhance conservation policies pertaining to coastal ecosystems. This is a major thrust of the funding institutions to which the conference organizers are very thankful. Hence, our heartfelt thanks to the Asia Pacific Network for Global Change Research (APN), the Department of Science and Technology (DOST) and the National Research Council of the Philippines (NRCP), and the Department of Environmental Science (DES) of the School of Science and Engineering (SOSE) of Ateneo de Manila University (ADMU). Likewise to the participants, speakers, guests and all those who have helped organize and implement the conference, our profound gratitude.

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Introduction

This Proceedings of the First National Seagrass-Mangrove Bioshield Conference provides documentation of the materials and the ideas and lessons they have engendered for all of us to consider seriously in making decisions about our coastal environment. It puts in a concise form, those materials, ideas and lessons that enhance appreciation of the least known of our coastal ecosystems –seagrass, and elicit concern to the most disturbed ecosystems of them all -the mangroves. Hence, it helps address one of the biggest gaps in conserving and managing these untapped resources –the lack of a deeper understanding of what they are, how they respond to disturbances, and how they are linked to our daily lives. The knowledge and information contained in this document are culled from 21 oral and 13 poster presentations, which are primarily outcomes of research projects of more than 80 participants from 45 institutions, hailing from 12 of the 17 regions of the Philippines.

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The Bioshield Concept

A conference revolves around the seminal concept of 'bioshield'. In the present context, it refers to the dynamic functions expressed as services of an ecosystem for the benefit of the environment and people. Seagrasses and mangroves as 'bioshields' points to their individual or collective role in protecting the coast from the negative impacts of both natural and human-induced stressors.
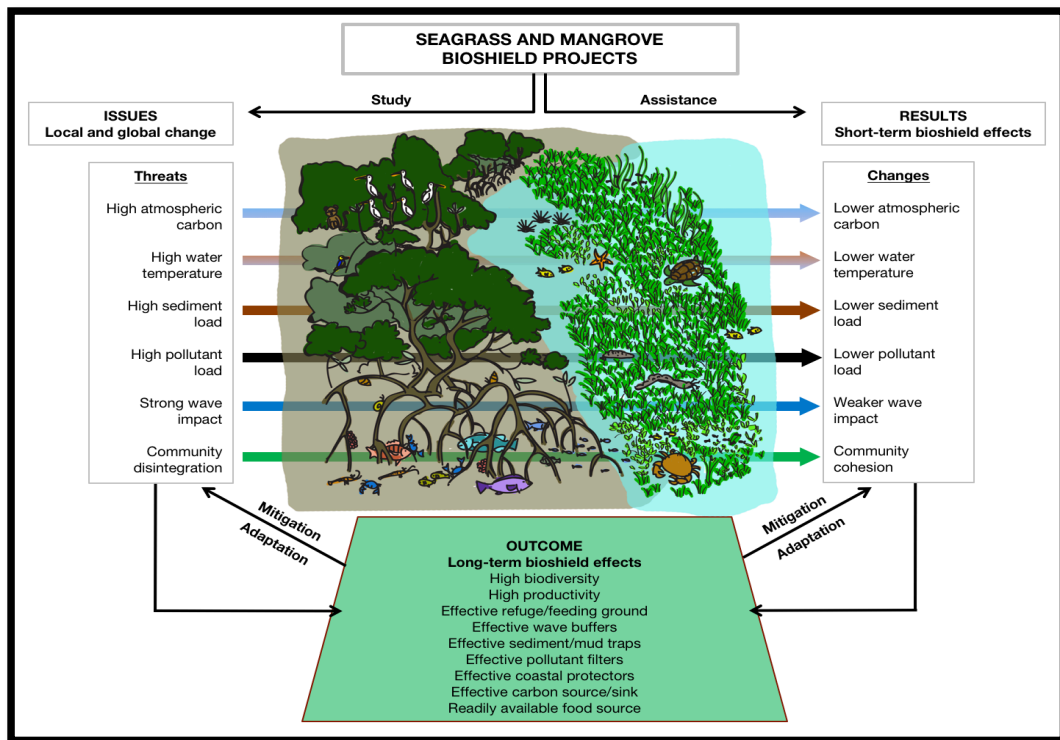
The concept of bioshield is visualized in the figure above. In its context, the conference relies on the role local projects play, which is to study how the issues and threats to the ecosystems could be fully understood so that the results could help reduce their impacts. This way, the long-term bioshield effects of the ecosystems are sustained, thereby facilitating their recovery and restore their services if disturbed. These services are the ecosystems' inherent properties, which, when fully understood, accepted, and adapted to by human communities, eventually ensure coastal environmental resilience and sustainability.

Salient Points of the Presentations and Q and A

Session 1: Seagrass and Mangrove Ecological Dynamics

Over the recent decades, research grants for marine science had been leaning more heavily on coral reefs, with mangroves and seagrasses receiving only a small slice as mere reef-associated components. Meanwhile, multiple pressures on the coastal zone continue to dislodge mangroves and seagrasses from their natural habitats, resulting in the significant reduction in the extent of mangroves and seagrasses over the past century. Today, the general indifference towards conserving the remaining seagrass meadows still prevails. In fact, despite the realization of some 200,000 ha of seagrass beds lost corresponding to the past mangrove planting efforts, the more recent initiatives simply continue this practice. The space-use conflict in the marine intertidal zone has resulted in (1) the reduction of both mangrove and seagrass habitats, (2) the massive re-engineering of the distribution and composition mangrove assemblages, and (3) more severely, the marginalization of seagrass beds. The consequences of such situation on the mangrove-seagrass ecological dynamics must be immeasurable. Thus, greater research efforts toward understanding mangrove-seagrass systems should be implemented, strengthening our scientific- and societal rationale for conserving these systems in the broader context of achieving nature-based solutions to coastal issues.

Recent advances in seagrass and mangrove studies include: modeling the recovery of mangrove populations after being damaged by storms, which showed that high seedling mortality and variable tolerance to environmental stressors are the dominant factors in mangrove species survival; fishing gear mapping overlaid with existing data on dugong sightings and seagrass beds, in order to enhance dugong conservation in Busuanga, which calls for marine spatial planning in order to minimize negative interactions between the local dugong population and small-scale fishing activities in the area; developing simple, easy and cheap transplantation technique of *Enhalus acoroi des*, conducted at Pari Island, Indonesia; assessment of the vulnerability of established *Rhizophora* stands in the monospecific Bantayan plantation against super typhoon Haiyan, which showed that existing *Rhizophora* plantations in the country >32 years old are likely to suffer mass mortality in the next super typhoon such as Haiyan; using *E. acoroides* to serve as proxies for studying the past history of sediment dynamics in muddy coasts; and investigating the relationships between dugong sightings, number and lengths of their feeding trails, and area of seagrass grazed, and with the number and frequency of tourists and weather conditions. The outcome is useful in policy decisions regarding seagrass and dugong conservation.

Session 2: Seagrass and Mangroves as 'Blue Carbon' Ecosystems

Seagrass beds and mangroves are considered 'blue carbon ecosystems' because of their capacity to sequester and store huge amounts of carbon. The capacity of these ecosystems to store carbon depends on their ecosystem health as well as the amount and quality of sediments delivered from adjacent watershed areas. In addition, the amount of carbon stored in these ecosystems might be negated by a rising sea level. Results from at least ten years of study on carbon stocks and sequestration on mangrove and seagrass in selected areas in the Philippines reveal some prospects to improve, and uncertainties that will limit, the carbon sequestration capacity so that strategies that

will help improve the national monitoring and reporting of carbon stocks as part of national mangrove and seagrass management programs are needed.

Some recent advances in blue carbon studies include: reversing the predicted seagrass and mangrove loss in the next 2 or 3 decades, particularly in the Philippines, via compilation of all available information on the two ecosystems, intensifying awareness and understanding of their services; assessment of the seagrasses and mangroves in Samar and Leyte to estimate the blue carbon in their living biomass.

Hence, three key actions are needed: (1) massive campaign to promote the importance of seagrass and its blue carbon; (2) development of a coherent national-wide monitoring network on changes in the essential parameters to use blue carbon in arresting biodiversity loss and in climate change mitigation, and (3) development of quantitative models predicting the responses to disturbance of seagrasses and flux of their blue carbon.

Session 3: Ecosystem Services and Improved Coastal Conservation

Currently in the Philippines, mangrove and seagrass maps are generated from the use, singly or in combination, of LiDAR, Worldview and other high-resolution satellite data, Landsat, and radar images. The availability of satellite images will increase due to programs such as Sentinel (Europe) and Phl-Microsat (Philippines), providing satellite images to the public. There is a need to increase the involvement of communities in mapping, monitoring, and conserving mangroves and seagrass meadows so that communities and local government units can be less dependent on larger scale mapping efforts, which are typically not conducted on regular periods. A system of data generation, analysis, feedbacks, revision, and communication of information must be in place to ensure that data, information, and local knowledge are used fully, effectively, and affectively towards conservation, management and sustainable use of our natural coastal resources.

More recent studies using satellites in order to enhance seagrass and mangrove conservation include: a study on the utilization of LiDAR data in monitoring the extent of mangrove reforestation and its impact on selected coastal barangays of Zamboanga City and in Southwestern Luzon using 2015 Landsat imagery; using LIDAR data in object-based image analysis for benthic habitat mapping, which shows that the data and its derivatives can be used in analyzing the seafloor and creating benthic habitat maps, which can be helpful in managing coastal environment; a study on the impact of collaboration with local and international organizations which has produced results faster than the pace in the previous decade in the establishment of MPAs and assistance for the operation, acquisition of funding and technical support and legislation among others; a study on the drawbacks of successful mangrove rehabilitation schemes, which concluded that the current practice of mangrove reforestation needs to be reviewed and evaluated to determine the trajectories of conservation objectives and that future mangrove rehabilitation programs should be conservation-oriented and technically-guided in order to somehow mimic the natural forest ecosystem services; a community based mangrove resource management and aquasilviculture which was successful in providing coastal conservation and livelihood in Davao del Sur; economic valuation of Triboa Mangrove Park, Subic Bay, which reported that the total economic value of the mangroves was estimated to be PhP 5,053,618 annually; an evaluation of the mangrove rehabilitation program in Liloan, Cebu, which advocates for the inclusion of science-based strategies to improve local rehabilitation efforts and consider a more ecosystem-based approach to the management of coastal and marine resources; mapping of dugong feeding trails in seagrass beds of Pujada and Mayo Bays, City of Mati, Davao Oriental, the data are now being used to enhance awareness of Local Government Units (LGU) and enforce strictly the existing laws to ensure dugong protection and

conservation both in local and global scale; and intensified campaign on conservation and management of the remaining mangrove forest in Davao Oriental which must be strengthened through community-based coordination and advocacy for sustainable resources.

Session 4: The Seagrass and Mangrove Factor in Community Resilience

Current research and advocacy efforts aim to establish, among others, a robust seagrass science in order to enhance resilience on the part of both the ecosystem and its dependent coastal communities in mitigating and adapting to the impacts of local environmental disturbances and climate variability. This is done principally by establishing an effective link between science and policy in implementing local seagrass conservation and capacity building in identifying and sustainably utilizing the ecosystem services. Indicators of success include: enhanced ordinances, actual physical and financial support to project needs, positive change in attitude towards science-based conservation, higher attendance in follow-up activities, 'more intelligent' questions, inputs on the part of participants in later discussions, and post-project implementation and pursuance of recommendations at the study sites. Along this line, studies have been conducted on rehabilitation of mangrove forest impacted by Typhoon Yolanda in Busuanga and Culion, Palawan. The objectives of the project are being realized through close collaboration and partnerships with the Local Government Unit of Busuanga and various organized community volunteer groups of selected barangays. Another project aimed at strengthening disaster preparedness through critical habitat (seagrasses and mangroves) conservation in Guimaras Province, its success measured in terms of actually adopting and implementing the MPA management plans, enhanced ordinances, active participation of the stakeholders, functional management board, financial and technical support to the project needs.

A seagrass 'bioshield' project highlighted the collective response of the ecosystem to act as bioshield, sustaining the productivity of the communities from the negative impacts from climate change. However, in Malita, the construction of a huge Coal Fired Power Plant (CFPP) in the vicinity of the dugong habitat remains the greatest challenge for the municipality. Another project initiated by CI-Philippines in the Verde Island Passage espoused coastal protection through mangrove reforestation. This included, to build the socioeconomic adaptive capacity of affected communities, income diversification initiatives.

Salient Points of the Panel Discussions and Q and A

Panel Discussion 1: "Sustaining the Services of Seagrasses and Mangroves"

Governance
- Who is/are mandated to update seagrass/mangrove national program?
- Why is our environment not improving substantially?
- Fund release and disbursement, extension of project duration?
- Success indicators for mangrove planting
- Difference in setting indicators among institutions
- Enforcement

Science and governance
- "Expensive " learning experience and process
- Inventory of initiatives done
- Setting of indicators – proxy, milestone, success
- Systematize methods for monitoring success
- Sustain documentation and monitoring
- Address primary cause of degradation before restoration
- Share and replicate best practices
- Need to research on land use/resource history of area before planting mangroves

Panel Discussion 2: "Developing the Framework of a National Blue Carbon Strategy"

Key concepts - Blue carbon, blue carbon ecosystems, resilience
Base actions
- Consolidation of all directly relevant local and national data and information
- Working on the initial progress in developing a National Blue Carbon Committee
- Tapping for support the Climate Change Commission, DENR, SIMSEA, USAID
- Take the opportunity for cross-cutting with Indonesia, Blue Carbon Initiative
- Regular meetings and updates

Strategies:
- Comprehensive assessment of trends
- Constituency building > capacity building > social capital ('banking')
  - Identifying most vulnerable sectors as the entry point
  - Diversification into social groups
  - Establishing common sources of funds
  - Investing in best practices
  - Rallying support of and for community leaders
- Need for a transdisciplinary approach
- Monitoring and evaluation (Ocean Health Index)
- Shifting to a 'blue carbon economy'
  - Overarching of mandates
  - Linking research and policy

- Blue carbon is not included in coastal protection management policies, no practice to incentivize blue carbon work unlike other countries.

Conclusions and Guides for Future Action

In the Philippines and among its major coastal ecosystems, coral reefs are the most popular, mangroves the most disturbed, and seagrass beds, the least studied. After almost 12 decades since the 1900s, this dictum remains. Because of unsustainable use of the ecosystems goods and services, outright neglect on the part of those mandated to protect them, meager understanding of their importance on the part of the greater populace, and inappropriate interventions used to conserve and manage the resources, we are witnessing an unprecedented demise of seagrasses and mangroves upon which the formative and mature years of the Filipino life depend. Despite a great number of studies, advocacies, policy reforms and billions of pesos and dollars spent, the question is being asked: *Have the state of these ecosystems in the Philippines improved*? While there are myriads of causes to which their degradation or loss are attributed, there are as many reasons why all concerned ought to stop finger-pointing and do something simple, small, but practical, concrete and effective –*NOW*! *People have to be reconnected with the ecosystems once more.*

This is the essence of the conference, translated into its theme, objectives and strategies. The conference strongly and with a sense of urgency recommends:

1. That greater research efforts toward understanding mangrove-seagrass system dynamics should be implemented, strengthening our scientific- and societal rationale for conserving these systems in the broader context of achieving nature-based solutions to coastal issues;
2. To intensify a localized and contextualized effort on the ecosystems' blue carbon potential, three key actions are needed: (1) massive campaign to promote their importance; (2) development of a coherent national-wide monitoring network on changes in the essential parameters to use blue carbon in arresting biodiversity loss and in climate change mitigation, and (3) development of quantitative models predicting the responses to disturbance of the ecosystems and flux of their blue carbon;
3. In order to conserve their ecosystem services and improve current conservation practices, a system of data generation, analysis, feedbacks, revision, and communication of information must be in place to ensure that data, information, and local knowledge are used fully, effectively, and affectively towards conservation, management and sustainable use of our seagrasses and mangroves;
4. Include blue carbon in coastal protection management policies, and promote practices that incentivize blue carbon work like other countries; and
5. To link seagrasses and mangroves directly to community resilience, current research and advocacy efforts should aim to establish a robust ecosystem science in order to enhance ecosystem and community resilience in mitigating and adapting to the impacts of local environmental disturbances and climate variability.

ABSTRACTS OF PRESENTATIONS

SESSION 1: SEAGRASS AND MANGROVE ECOLOGICAL DYNAMICS

OP. 1: (Plenary Paper)

Marginalizing mangroves and seagrasses amidst space-use conflict in the marine intertidal zone

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The relevance of conserving the natural distribution of mangroves and seagrasses in sustaining coastal ecological connectivity has long been established. However, studies quantifying such connectivity had been meager, and more particularly so in the Philippine setting. Over the recent decades, research grants for marine science had been leaning more heavily on coral reefs, with mangroves and seagrasses receiving only a small slice as mere reef-associated components. Meanwhile, multiple pressures on the coastal zone (mine tailings / sedimentation, reclamation, other coastal development, aquaculture, mangrove afforestation, etc.), continue to dislodge mangroves and seagrasses from their natural habitats, resulting in the significant reduction in the extent of mangroves and seagrasses over the past century. As we already know, the greater amount of mangrove losses (> 65%) could be attributed to the proliferation of brackish-water aquaculture ponds. Efforts to regain mangrove losses had been various and vigorous, reflecting an increase of 200,000 ha in national coverage during the past two decades. More recently, with funds from the National Greening Program and the Post-Yolanda initiatives, such figure would be expected to increase even more significantly. In contrast, efforts to regain seagrass losses had been practically nil, and if at all, only in pilot scales. Some studies were done on seagrass transplantation feasibilities, as well as, artificial seagrass systems. However, until today, these pilot efforts have not yet been scaled up.

Today, the general indifference towards conserving the remaining seagrass meadows still prevails. In fact, despite the realization of some 200,000 ha of seagrass beds lost corresponding to the past mangrove planting efforts, the more recent initiatives simply continue this practice. Evidently, the practice had been relocating mangroves to the lower intertidal zone, and generally in monospecific stands, displacing vast areas of seagrass meadows. Contrary to how some may think, the multi-species seagrass meadows in the intertidal areas are generally unable to 'retreat' to deeper areas beyond their depth limits. In short, the space-use conflict in the marine intertidal zone has resulted in (1) the reduction of both mangrove and seagrass habitats, (2) the massive re-engineering of the distribution and composition mangrove assemblages, and (3) more severely, the marginalization of seagrass beds. The consequences of such situation on the mangrove-seagrass ecological dynamics must be immeasurable. Thus, greater research efforts toward understanding mangrove-seagrass systems should be implemented, strengthening our scientific- and societal rationale for conserving these systems in the broader context of achieving nature-based solutions to coastal issues.

OP. 2: An Agent-Based Model of Post-Disaster Mangrove Forest Regrowth

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Mangrove forests are helpful in the protection of coastal areas from dangerous water waves. They also provide a source of livelihood for coastal populations. Individual mangrove species can be very specific about their living conditions; only thriving in environments that match their preferred levels of salinity, inundation, pH and oxygen conductivity. It should also be noted that mangrove populations are vulnerable to natural phenomena, like storm surges and changes in sea level.

This study aims to accurately model the recovery of mangrove populations after being damaged by storms. It adapts published models of the individual growth and population dynamics of mangrove forests to a virtual environment based on the Bangrin Marine Protected Area in Pangasinan, Philippines. The environment features variable salinity and inundation per unit area, and the random occurrence of storms. The model includes planted mangroves (*Rhizophora mucronata*) and natural mangroves (*Avicennia* and *Sonneratia spp.*), which have different levels of sensitivity to environmental factors.

Simulations were run over a span of a hundred years for an approximation of the real-world mangrove plot, plus some possible alternative planting strategies. High seedling mortality and variable tolerance to environmental stressors were shown to be the dominant factors in the mangrove species' survival. Natural mangrove species, with greater tolerance to these stressors, displayed stable population densities in the long term. The planted *R. mucronata* populations tended to decline over time.

The successful implementation of this project may help local and national government estimate the time and extent of the recovery of mangrove populations damaged by storms. With the requisite site data, it can also be extended to mangrove populations in other sites and/or of different species.

OP. 3: The overlap of small-scale fishing activities and dugong (*Dugong dugon*) critical habitats in selected communities of Busuanga, Palawan

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Dugongs are critically endangered in the Philippines and Palawan is regarded as one of the final strongholds for the species. Due to the high number of dugong mortalities in Busuanga, Palawan being attributed to the overlap of fishing activities with dugong (*Dugong dugon*) critical habitats in the area, this study aims to document the different kinds of small-scale fishing done in the area and examines the nature of their interactions with dugong critical habitats previously identified by C3 Philippines. The study mapped out all different kinds of small-scale fishing from both capture fisheries and mariculture, including the approximate location of each activity through a participatory exercise of gear map. The gear map was then overlaid with existing data on dugong sightings and seagrass beds, further validated through site visits.

Trammel nets, seaweed farms and fish cages overlapped with both dugong sighting areas and seagrass beds. Dugong sighting areas in the vicinity of these activities had reports of multiple animals in a single sighting as well as the presence of juveniles. Seagrass beds in the vicinity of these activities had both dugong-preferred seagrass species and dugong grazing evidence.

Effective dugong conservation in these areas calls for marine spatial planning in order to minimize negative interactions between the local dugong population and small-scale fishing activities in the area.

OP. 4: Transplantation Seagrass Method by Using Crowbar: Simple, Easy, and Cheap

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Transplantation of seagrass was pioneered by Addy (1947), which used the seed of *Zostera marina* as the seedlings. Fonseca *et al.* (1998) launched protocol for transplantation of temperate seagrasses. Until now there is no guideline or protocol for transplantation of tropical seagrasses. The RCO-LIPI tried to built the protocol of transplantation of tropical seagrasses, starting from *Enhalus acoroides*.

The aim the study is to develop the simple, easy and cheap transplantation technique of *Enhalus acoroides*, which was conducted at Pari Island, Jakarta-Indonesia. Technique of transplantation is single shoot of *Enhalus by* using crowbar. Planting units of *Enhalus* are 1 x 10 m with density of seedlings 9 shoots.m^{-2} and density of seedlings 25 shoots.m^{-2} in 3 replicates. Survival growth of seedling from density of seedlings 9 shoots.m^{-2} (94.90 ± 4.34 %) is lower than that from density of seedlings 25 shoots.m^{-2} (96.08 ± 2.48 %). The simple and cheap transplantation technique of *Enhalus* by using crowbar can be developed for transplantation of other tropical seagrasses and as marine tourist attraction. The crowbar can be replaced by sharpened wooden or bamboo sticks.

OP. 5: Fate of Existing *Rhizophora* Plantations against Super Typhoons: Mass mortality beyond age-thresholds

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In the aftermath of super typhoon Haiyan, which devastated central Philippines on 08 November 2013, mangroves gained renewed national interest. Other than claiming thousands of lives and displacing millions of people, Haiyan wrought massive damage to infrastructure, crops, and coastal systems including mangroves. Mangroves are widely known for its various ecosystem services, e.g. habitat, nursery ground, carbon sequestration, nutrient cycling, wind and wave barriers. Over the past decades of perceived severe decline in mangrove cover, massive mangrove planting programs had been the logical response, albeit focusing on creation of dense, monospecific *Rhizophora* stands. This practice resulted in high mortality, low growth rates, and conflict with conservation of existing seagrass and mudflat habitats. Initial post-Haiyan surveys revealed higher vulnerability of *Rhizophora* spp., being unable to produce epicormic sprouts unlike other mangrove taxa (e.g., *Sonneratia*, *Avicennia*, *Aegicera*s, etc.). This study assessed the vulnerability of established *Rhizophora* stands in the monospecific Bantayan plantation against super typhoon Haiyan. Community structure, damage type, and recovery responses were assessed in stands of different year of establishment. Results show that 45% of the *Rhizophora* plantation was severely damaged by super typhoon Haiyan. Older stands experienced >97% mortality while younger stands (<9 years) completely recovered at 1.7 years post-Haiyan. Trees located in the periphery also exhibited higher survival compared to the plantation core. Using the age-threshold model from the Obo-ob data, mass mortality (95%) was calculated to be at 33 years, and 50% mortality is at 27 years old. This study implies that existing *Rhizophora* plantations in the country >32 years old are likely to suffer mass mortality in the next super typhoon such as Haiyan. Similarly, younger plantations would eventually suffer mass mortality upon reaching the age threshold. Thus, current mangrove rehabilitation and enhancement practices apparently need further rethinking to improve mangrove forest resiliency in the face of typhoon impacts.

OP. 6: Impacts of planting mangroves in seagrass beds: A brief review

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The intricate relationship between seagrass meadows and people highlights the multi-functional role of seagrasses in human wellbeing. The beds enhance and support diversity of associated fauna, which in turn are utilized by people for income generation. Mangrove forests are also important and highly valuable ecosystems and like seagrass beds, they are currently under accelerating rate of destruction due to natural and/or man-made disturbances. In Philippines, young mangroves are planted in some coastal areas, including seagrass beds, for fisheries, protection, and biodiversity purposes. Available yet limited researches suggest that mangroves should not be planted in seagrass-vegetated areas since they are not supposed to be there. However, specific rationale behind this is not clearly explained, despite the potential influence of mangrove planting in altering the social and ecological resilience.

Planting of mangroves in coastal areas that are not within their natural range is a form of habitat conversion. The later disturbance may eventually lead to alteration in associated faunal structures of the converted/disturbed habitat. The importance of seagrass beds in supporting high biodiversity, provision of food and refuge to associated animals, needless to say their ecosystem services, may have been often overlooked over planting of mangroves in the country. In fact, seagrass ecosystems are diminishing in extent worldwide and repeated studies confirm a lack of appreciation for the value of these systems. Knowledge on the impacts of mangrove planting in seagrass beds will have important contributions to seagrass conservation and coastal resource management. Future researches integrating changes in seagrass complexity, ecological diversity of the associated animals, status of human wellbeing (e.g., income, aesthetic/cultural services), and how people value/see the importance of mangrove planting, may aid in developing a more comprehensive understanding of impacts of man-made disturbances to seagrass ecosystems.

PP. 1: *Enhalus Acoroides* (L.*f.*) Royle Seagrass Rhizomes:
A Potential Proxy for Coastal Sedimentation Patterns in Relation to Climate Change

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Given the growing frequency of extreme weather events, and increasing rain intensities associated with typhoons, it is relevant to address sedimentation of muddy coastal habitats through time and the consequent responses of coastal ecosystems. As there are no long-term records of coastal sedimentation and a dearth of information on sedimentation in shallow coastal areas, this study aims to develop a proxy for sedimentation using the large, long-lived tropical *Enhalus acoroides* seagrass rhizomes for studying coastal sedimentation and erosion in relation to climate change patterns. This will be achieved through i) describing the sediment dynamics of a muddy coast through time, based on the rhizome geometry of *E. acoroides*; and 2) correlate derived sediment dynamics with long-term records of environmental parameters.

E. acoroides rhizome samples of at least 5-years of age were collected from Barangay Mayao Castillo, Lucena, Quezon. Age-estimation techniques were applied to the seagrass rhizome internodal series and their annual growth cycles determined. The geometry of each rhizome sample was plotted to obtain a general pattern of the the rhizome contour in time. Rhizomes were examined for the presence of common signatures that may be indicative of historical perturbation i.e. storms. Remotely sensed long-term environmental data were downloaded from open sources and correlated with the time series on interannual rhizome internodal growth and the general rhizome contour pattern. General patterns consisted of continuous diagonally downward orientation of the rhizome indicative of erosion (usually associated with El Niño); steep rises indicative of a major perturbation associated with high sedimentation (and La Niña periods); and horizontally oriented rhizomes indicative of relative sediment equilibrium during none event periods. Net sedimentation and erosion rates through time were likewise estimated from the rhizome geometry. The common *E. acoroides* can serve as good proxies for studying the past history of sediment dynamics in muddy coasts as they are affected by the varying precipitation patterns influenced by ENSO-related climate change. Part of seagrass conservation work should include regular monitoring of coastal sedimentation within seagrass ecosystems, through which the natural records of *E. acoroides* can be used for areas with no coastal sedimentation monitoring program.

PP. 2: Seagrasses and Mangroves: Bioshield Against Biodiversity Loss and Impacts of Local and Global Change Along Indo-Pacific Coasts

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At seagrass and mangrove sites in the Philippines, India and Indonesia, we determined the nutrients, biodiversity, plant, macroinvertebrate and fish density, plant biomass and growth rates. These were correlated with key disturbance parameters, both natural and human-induced, including unsound laws. The results indicate a potential collective response of the ecosystems to act as bioshield, protecting and sustaining the productivity of the communities from the negative impacts of fish cage effluents and climate change. In addition, using the acoustic video camera DIDSON, we observed the underwater behavior of *Dugong dugon* (dugong) and obtained 3D video images of the bottom, giving rough estimates of seagrass density and distribution. In the case of mangroves, mono-specific plantation of *R. stylosa* significantly reduced species richness and variety of the mangrove vegetation. The policy implication of this finding is worth looking into in the light of massive financial and institutional support the current mangrove reforestation program of the Philippines and Indonesia get, using only *Rhizophora*. Thus, we argue in favor of a growing consensus, which places seagrass-mangrove system conservation as priority, developing a model of the ecosystems focusing on their 'bioshield' functions in mitigating local and global changes along Indo-Pacific coasts.

In the context of bioshield, the role our projects play is to study how the issues and threats to the ecosystems could be fully understood so that the results could help reduce their impacts. This way, the long-term bioshield effects of the ecosystems are sustained, thereby facilitating their recovery and restore their services if disturbed. These services are the ecosystems' inherent properties, which, when fully understood, accepted, and adapted to by human communities, eventually ensure coastal environmental resilience and sustainability.

PP. 3: Dugong grazing and their behavior in seagrass beds in Malita, Philippines

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Underwater monitoring of dugong grazing in seagrass beds were done quarterly in December 2011 - June 2014 in New Argao, Malita, Davao del Sur, Philippines. Substrate ranged from coarse, to very fine sand, with shell fragments of foraminiferans. Depth for observed dugong trails ranged from 3 to 18 meters. Some macroinvertebrates were present along the dugong trails since they feed on the benthic fauna that are displaced by sediment disturbances caused by foraging and water movement. Dugongs make distinct trails through seagrass beds during feeding indicated by the tracks of vegetation removed. Percent cover of seagrass area, grazed (=dugong trail) and ungrazed, was photographed inside a 0.25 sq. m quadrat. Seagrass species grazed by the dugong were mostly, and not exclusive to, *Halophila* and *Halodule*. In February (2014), there was a high occurrence of fresh dugong trails, while in June, the trails observed were about a week old. In December 2011, *Halophila ovalis* had an overall mean (n = 25-35) of 30% cover, *Halodule uninervis,* 32.5%, and a dugong feeding trail area of 37.5% of the quadrat. In November 2013, *H. ovalis* had a mean 17.5%, *H. uninervis* (narrow-leaf) 38.3%, *H. uninervis* (wide-leaf), 10%, while the trails averaged 14.30%. In February 2014, cover of *H. ovalis* was 42.7%, *H. uninervis* (narrow-leaf) 16%, *H. uninervis* (wide-leaf) 7.3%, and the trails 24.4%. In June 2014, *H. ovalis* had 26.5%, *H. uninervis* (narrow-leaf) 20.8%, *H. uninervis* (wide-leaf) 15.8%, and *Halophila spinulosa*, 45%. There were no feeding trails in February 2014. Comparing the seagrass area in February 2012 and May 2013, there was a clear diminution in the latter month, with the absence of *Cymodocea serrulata* and *Halophila spinulosa.* No clear relationship exists between the seagrass cover and the frequency of dugong feeding trails in the area.

Dugong sightings were plotted with time of day, number of individuals versus disturbances (boats and picnickers) as well as sea-surface temperature during the period. There was a higher frequency of occurrence of dugongs when there were more picnickers present in the area. In addition, fewer individuals are seen when boats were nearby. There were peaks in occurrence at 9 - 10 AM, becoming lower at 1 to 2 PM. Further studies are needed to acquire more definitive information especially on the seagrass cover- dugong feeding behavior relationship.

SESSION 2: SEAGRASS AND MANGROVES AS 'BLUE CARBON' ECOSYSTEMS

OP. 1: (Plenary Paper)

Prospects and Uncertainties in Carbon Sequestration Potential of Mangroves and Seagrass in the Philippines

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Mangroves and seagrass are considered blue carbon ecosystems because of their capacity to sequester and store huge amounts of carbon. The capacity of these ecosystems to store carbon depends on their ecosystem health as well as the amount and quality of sediments delivered from adjacent watershed areas. With vast mangrove and seagrass habitats in the archipelago, the Philippines has the potential to sequester atmospheric CO_2. If properly planned and managed, current massive mangrove rehabilitation programs may also significantly contribute in capturing carbon. However, both ecosystems are threatened by anthropogenic pressure (e.g. conversion to aquaculture ponds) and natural stresses particularly their capacity to regenerate after the occurrence of a catastrophic typhoon. In addition, the impacts of projected sea level rise will result to prolonged inundation and possible landward migration that might reduce their spatial extent and distribution. Hence, the amount of carbon stored in these ecosystems might be negated by a rising sea level. In this study, results from at least ten years of study on carbon stocks and sequestration on mangrove and seagrass in selected areas in the Philippines are reviewed and evaluated. Prospects to improve, and uncertainties that will limit, the carbon sequestration capacity are also assessed. Strategies that will help improve the national monitoring and reporting of carbon stocks as part of national mangrove and seagrass management programs are discussed.

OP. 2: Framing the future of seagrass blue carbon studies in the Philippines

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In the Philippines, seagrasses cover at least 27,282 ha of the coastal zone. They develop highly productive ecosystems, which fulfill a key role in the sustainability of coastal and marine environment. Both direct and indirect human impacts, however, cause widespread seagrass loss, and this loss is aggravated by natural causes, such as rise in seawater temperature and typhoons. The study gives insights on such threats and trends and considers likely changes in the next 2 to 3 decades, focused on seagrass carbon. Present losses are expected to accelerate, particularly in the Philippines due largely to growing demands on the coasts from the rapidly expanding, but less knowledgeable and concerned population. On the other hand, slow but significant reversal of this trend is emerging, due in large part to increased local legislation to protect seagrass, increased protection of coastal ecosystems, and enhanced efforts to monitor, restore the marine ecosystem, plus international pressure to effect these changes. However, these positive changes are expected

particularly in those parts of the country, where the capacity to understand the basis of implementing conservation policies is solid. True globally, uncertainties as to the present area of seagrasses, rate of loss, lack of and incoherent monitoring projects and programs and the present paucity of studies on blue carbon, represent a major barrier to the formulation of national policies that encourage its application in climate change mitigation. Here, three key actions are needed: (1) massive campaign to promote the importance of seagrass and its blue carbon; (2) development of a coherent national-wide monitoring network on changes in the essential parameters to use blue carbon in arresting biodiversity loss and in climate change mitigation, and (3) development of quantitative models predicting the responses to disturbance of seagrasses and flux of their blue carbon.

PP. 1: Assessing the blue carbon in living biomass of seagrasses in Eastern Samar and Leyte

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The ability of seagrasses to sequester and store carbon from the atmosphere makes them a valuable resource in mitigating and adapting people to the impacts of climate change. In this study, the seagrasses in Samar and Leyte were assessed to estimate the blue carbon in their living biomass. Out of the 13 sites, 4 sites in Samar and only 2 municipalities in Leyte had seagrass beds. Multi-species beds in Eastern Samar were dominated by *E. acoroides*, *T. hemprichii* and *C. serrulata*. In Leyte, there is a contrast between the species composition of Tacloban and Abuyog. Tacloban is dominated by large species (*E. acoroides, C.serrulata, T. hemprichii*) while Abuyog consists mainly of small species (*H. uninervis, H. pinifolia*). The variety of species found on these sites translates to different characteristics in terms of mechanisms in carbon capture and storage. Sites with large seagrass species tend to have higher cumulative blue carbon content compared to sites with mostly small species. *E. acoroides* and *C. serrulata* contributed a significant amount of carbon in these sites. Belowground biomass has up to 2x the carbon content of the aboveground parts. Carbon in belowground parts is more likely favorable to long term storage of blue carbon. This study is an initial step to quantify blue carbon in the area.

SESSION 3: ECOSYSTEM SERVICES AND IMPROVED COASTAL CONSERVATION

OP. 1: (Plenary Paper)

Conserving Mangroves and Seagrass and Enhancing their Ecological Services through Community, Science, and Technology Partnership

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Mangroves and seagrass offer various ecological services including protective services. Both significantly reduce wave energy and in the case of mangroves, protection from strong winds can be realized. It is known that mangroves and seagrass have suffered decimation through the years, with causes attributed largely to anthropogenic factors. Thus, it is necessary to periodically map these coastal resources at greater detail possible. To date, various coverage estimates and maps of mangroves in the Philippines exist. In contrast, maps and estimates of seagrass cover based on remotely sensed are comparatively less available and less accurate. This is primarily due to the complexity involved in dealing with water column effects, including water quality issues. It is also crucial to come up with methods that would give acceptably accurate results so that comparison across different months and years. This comparison suffers not only from the differences in methods and data used but also in the non-regularity in the frequency of mapping efforts. Currently in the Philippines, mangrove and seagrass maps are generated from the use, singly or in combination, of LiDAR, Worldview and other high-resolution satellite data, Landsat, and radar images. The availability of satellite images will increase due to programs such as Sentinel (Europe) and Phl-Microsat (Philippines), providing satellite images to the public. These remotely sensed data must be fully exploited to provide increasing levels of information by employing sub-pixel estimation approaches and algorithms for separating mangrove classes, and estimating biomass. For the latter, the three-dimensional structure is needed and can be provided through LiDAR and radar remote sensing. More than just mapping the extent and the changes thereof, it is imperative to analyze these changes and trends spatially and temporally to identify factors leading to or controlling these changes and trends. With this attribution, conservation efforts can be enhanced. Considering climate changes and the associated uncertainties, modeling and simulating growth dynamics of mangroves and seagrasses using knowledge obtained through scientific experiments is necessary. This is to further understand the effects of climate change and other elements, and thereby, develop measures to ensure ecological services are maintained and to mitigate the impacts of climate change. There is a need to increase the involvement of communities in mapping, monitoring, and conserving mangroves and seagrass meadows. Community mapping not only provides local knowledge translated into maps but also increases awareness and appreciation of these coastal habitats. Through this, more frequent and responsive assessments of mangroves and seagrass can be made and communities and local government units can be less dependent on larger scale mapping efforts, which are typically not conducted on regular periods. In so far as geo-information management is concerned, the challenge is to integrate such local knowledge with those products produced by the authorities, experts, and specialists through automated processing. A system of data generation, analysis, feedbacks, revision, and communication of information must be in place to

ensure that data, information, and local knowledge are used fully, effectively, and affectively towards conservation, management and sustainable use of our natural coastal resources.

OP. 2: A Study on the Utilization of LiDAR data in Monitoring the Extent of Mangrove Reforestation and its Impact on Selected Coastal Barangays of Zamboanga City

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Mangroves serve as the foundation to complex marine and terrestrial food chains, as well as feeding, breeding and nursery grounds for a myriad of wildlife. Not only do mangrove forests sustain high levels of biodiversity and productivity, but capture nutrient-rich sediments, stabilize soils, act as a natural barrier to coastal communities, and prevent erosion as well. Mangrove forests are also incredibly efficient carbon sinks. However, due to anthropogenic forces, Philippine mangroves have declined to only 120,000 hectares. Mangrove replanting programs have thus become widespread, from community initiatives to government-sponsored projects to large-scale international development assistance programs.

In Zamboanga City, mangrove depletion has been widespread due to conversion of mangrove forests into fishponds, deforestation due to the expansion of human settlement, and the aftermath of the Zamboanga siege in 2013. Rehabilitation efforts have been implemented to compensate for the decline but afterwards, coastal morphology has become unmonitored. Despite heavy funding for massive mangrove reforestation, long-term survival rates are low which can be traced to inappropriate species and poor site selection. To address this issue, this study was undertaken to incorporate the potential of emerging geospatial information techniques using LiDAR or Light detection and Ranging. LiDAR is a remote sensing method that uses laser technology to generate 3D image models of the surveyed area. Using LiDAR data and semi-automated object based classification, the study aims to develop relevant geospatial data to serve as a baseline data for conservation management such as assessing site selection, monitoring mangrove depletion, and coastal change detection. Generated resource maps provide stakeholders, policymakers, and planners with a framework for the integration of remote sensing techniques and sustainable coastal management.

OP. 3: Mangrove Forest Extent Mapping in Southwestern Luzon Using 2015 Landsat Imagery

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Accurate spatial information of mangrove forest extent is essential for both land-use planning and natural resources management. In this study, we assessed the spatial distribution of mangrove forest in Southwestern Luzon provinces for the year 2015 using publicly available Landsat data. The images were Landsat calibrated and atmospherically corrected using the FLAASH algorithm.

Support Vector Machine (SVM) was used to classify the images to 4 classes (i.e., Mangroves, terrestrial non-mangroves vegetation, built-up plus bare soil and cloud cover plus shadows). Results generated a total area of mangrove forest cover per province: 42,999 ha in Palawan; 397.6 ha in Batangas; 3,259 ha in Oriental Mindoro, 1,386 ha in Occidental Mindoro, 137.4 ha in Cavite and 10,570 ha in Quezon. In general, the mangrove extent estimates in our study were comparable to previous remote sensing studies conducted in the Philippines. Although there are some discrepancies with the results, overall accuracy above 95% and kappa coefficient above 0.9 show that mangrove estimates are accurate. The results of this study are an important contribution to rapid ecological assessment of mangroves; and can aid in conservation and management studies.

OP. 4: ICM Mechanisms Promote Multi-Stakeholder Critical Habitat Conservation in Guimaras Island, Philippines

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Environmental conservation has intensified since the M/T Solar I oil spill incident in 2006 but sporadic conservation efforts in the Island-Province of Guimaras remains a challenge to conservation endeavors. The tragedy took away invaluable coastal habitats and their resources, which prompted many organizations to develop conservation initiatives with the support of local and foreign agencies. The local mainstay organization, Guimaras Environment and Natural Resources Office (GENRO) has scarce resources for the huge sets of tasks and works to coordinate with as many stakeholders as possible. The implementation of Integrated Coastal Management Program uses the coordination and integration mechanisms for effective partnerships among stakeholders in the transition between independent to inter-dependent and extensive or intensive management of coastal habitats.

Collaboration with local and international organizations has produced results faster than the pace in the previous decade with establishment of MPAs and assistance for the operation, acquisition of funding and technical support and legislation among others. The current partnership between UP-MSI and GENRO supported by Yeosu III Project is studying the growth and survival of planted mangroves. Educational campaign materials were also developed and released to development partners while integration to local school curricula is underway. Partner organizations such as USPC, KOICA, GIZ and Australian Aid among others, have developed the capabilities of GENRO and partner agencies.

The study presents activities and their outcomes for the conservation of seagrass, mangroves and coral reefs including accounts on the challenges, opportunities, experiences and plans of GENRO-ICM Program.

OP. 5: Drawbacks of successful mangrove rehabilitation schemes: lessons learned from the renowned mangrove plantations

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Mangrove rehabilitation programs received much attention in the past decades as a response to widespread global degradation. While the documented successes and failures of mangrove rehabilitation accomplishments were varied, the objective and scheme is common, which is mainly focused on planting and creating monospecific plantations. This study assessed the renowned large-scale *Rhizophora stylosa* plantations in Banacon and Olango Islands in the central part of Philippines in terms of vegetation structural development and species composition, and compared its similarity with the adjacent natural stand as reference. Our study shows that secondary succession in the densely monospecific plantation in Banacon Island was inhibited as reflected by low regeneration potential, whereas recruitment and colonization of non-planted species was promoted in Olango Island. Even after 60 years of its establishment, the plantation in Banacon Island still lacked the understory of young cohorts, which together comprise the regeneration potential that can supposedly add to the structural complexity. Although a potential seedbank from adjacent natural forest is available, recruitment and colonization of non-planted species did not progress. MDS analysis of the tree density data showed a clear clustering of planted forest from the natural stand with average SIMPER dissimilarity of 79.9%. Generally, it is almost impossible to restore the degraded habitat to its original state and the principal goal of restoring it is to reproduce as much as possible the characteristics and functions of natural forest. However, even after several decades, the planted forest shows no sign of mimicking the characteristics of a natural forest. Though Banacon Island has been portrayed as an exemplary and successful community-based mangrove reforestation, it is only viewed in its socio-economic aspect, and had proven that the local people can be effective forest stewards and efficient day-to-day resource managers. The current practices of mangrove reforestation needs to be reviewed and evaluated to determine the trajectories of conservation objectives. Future mangrove rehabilitation programs should be conservation-oriented and technically guided in order to somehow mimic the natural forest ecosystem services.

OP. 6: Community Based Mangrove Resource Management and Aquasilviculture:
A Coastal Conservation and Livelihood Project in Davao Del Sur

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The project is geared towards community-based mangrove resource management and aquasilviculture under the Philippine National Aquasilviculture Program (PNAP) envisioned to attain food security, ensure sustainable development of fisheries resources and reduce poverty incidence among coastal communities. Specifically, the organized communities were strengthened and capacitated by providing an appropriate education, training and skills in the proper utilization of the resource ecosystem-a tool in sustainable development. The program has three (3) project components i.e. Mangrove Resource Rehabilitation & Enhancement, Aquasilviculture: Sustainable Livelihood Project and Community-Based Multi-Species Hatchery with allotted budget of P7, 468, 960.00 solely for Davao del Sur.

A total of 433 coastal households (261 males & 172 females) served as beneficiaries/recipients of the project. These covered the eight (8) municipalities and one (1) city (with nineteen (19) barangays) in the whole Province. The beneficiaries were able to plant 636,000 mangrove propagules covering a total of 201 hectares along the coastal stretch of Davao del Sur. A total of P 2,226,000.00 was received by the beneficiaries in the collection *(at P1.50 per propagule)* and planting *(at P2.00 per propagule)* of mangrove propagules.

As of the last validation with the Project Monitoring Team, there were a total of 346,149 fully grown mangroves and with these; beneficiaries were paid a total amount of P865, 372.50 *(at 2.50 per tree).* On the other hand, for the aquasilviculture venture, there were fifteen (15) techno-demo farms installed and stocked with Mudcrab. Purposely, the community-based hatchery project facilities and amenities was rehabilitated and upgraded to provide seed stocks to these aquasilviculture sites.

OP. 7: Economic Valuation of Triboa Mangrove Park, Subic Bay, Philippines

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Mangrove forests are among the most important coastal resources in the Philippines, known to provide wide variety of ecological services and products, which sustains social, environmental and economic activities. However most of these services have no market value and hence the full value of mangrove ecosystem is underestimated consequently, it is being traded for development and conversion into aquaculture ponds, ports and residential estates. Subic Bay mangrove forest faces this treat considering that SBMA mission and vision is to become globally competitive economic maritime hub. This study intends to determine the true value of Triboa mangrove in Subic Bay Freeport Zone using contingent valuation method. Willingness to pay survey was used to assess the stakeholders' awareness on the importance of mangrove and how the stakeholders value these ecosystems. Results showed that income, educational attainment and environmental awareness are

directly correlated to willingness to pay. In addition, the total economic value of the mangrove was estimated to be 5,053,618 pesos annually. This valuation can be used as basis for better management and conservation of mangrove forest in Subic Bay Freeport Zone.

PP. 1: Evaluation of the Mangrove Rehabilitation Program in Liloan, Cebu

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Impact of recent environmental catastrophes exacerbated dismal conditions of mangrove rehabilitation programs in the country, requiring a pragmatic review of past initiatives. With funding from UNICO Conservation Foundation, the Coastal Conservation and Education Foundation, Inc. (CCEF) conducted the Coastal Forests Conservation Project with the following objectives: 1) assess status of rehabilitated sites vis-à-vis "natural" growth forests; 2) evaluate impact of mangrove conservation and management initiatives through stakeholder analysis and perception mapping; 3) enhance capacity and constituency building for a programmatic approach to coastal forest conservation; and 4) policy advocacy in support of promoting the establishment of a mangrove greenbelt in vulnerable coastal areas in Cebu.

The Municipality of Liloan is selected by CCEF as the pilot site for assessment using established tools by English et al., 1997 and Primavera et al., 2004. Comparative historical mapping of mangrove extent was done using Google maps.

Only 2% of the total natural mangrove forest cover was assessed. At least six mangrove species were found, with *Avicennia marina* predominating, followed by *Rhizophora stylosa,* adult trees of which were also observed landward. Rehabilitated areas were planted solely of *Rhizophora stylosa,* seaward side, encroaching in seagrass beds. Other threats include: reclamation for port construction and conversion for private housing development; unmanaged solid waste. Major recommendations include the inclusion of science-based strategies to improve on local rehabilitation efforts and consider a more ecosystem approach to the management of coastal and marine resources. The Municipal Agricultural Office is currently leading the update of Liloan's 5-year Integrated Coastal Management.

PP. 2: Object-Based Image Analysis for Benthic Habitat Mapping using LiDAR Derivatives

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Benthic pertains to anything that occurs on the bottom of a water body. Benthic habitats support various marine life, thus, it is important to preserve and manage these areas. To better facilitate the management and analysis, we need to look at its condition through the use of maps. These maps can improve our understanding of the relationship between the habitats and the seafloor.

There are many approaches in creating benthic habitat maps, one of which is through the use of Light Detection and Ranging (LiDAR). It is a remote sensing technique, which uses light pulses to measure distances and to generate three-dimensional point clouds of the Earth's surface. In this study, the bathymetric LiDAR - a type of LiDAR, which uses green light to penetrate the water and measure elevations, will be used to analyze the geophysical features of the seafloor and create a benthic habitat map.

The bathymetric LiDAR dataset were first pre-processed using LASTools, specifically *las2las*, to remove the surface water points and extract only the bottom surface, which contains the habitats. LASTools is a software used for processing LiDAR data. A Digital Surface Model (DSM) was then created using *las2dem* to define the topography of the seafloor. From the DSM, other LIDAR derivatives such as Mean Depth, Standard Deviation of Depth, Curvature, Plan Curvature, Profile Curvature, Rugosity, Slope, Slope of Slope, Fractal Dimension, Broad-scale and Fine-scale Bathymetric Position Index (BPI) were generated. Each of these surfaces highlights distinct features of the seafloor as well as its complexity. Since the eleven derivatives all originated from the DSM, a Principal Component Analysis (PCA) was done using ArcGIS to remove the redundancy of the information found on these surfaces. This process reduced the twelve correlated LiDAR-derived surfaces into just three uncorrelated output bands called *principal components*. Then, an Object-based Image Analysis (OBIA) was performed using eCognition. OBIA analyzes a group of pixels with similar properties called *objects*, as compared to the traditional pixel-based, which only examines a single pixel. Multi-threshold and multiresolution segmentation were used to delineate the habitats and split the image into objects. These objects were then assigned into different classes such as sand, seagrass, seaweed, corals, coral ruble, and dead coral with algae, using hierarchical and semi-automated classification. Semi-automated classification includes Nearest Neighbor, Feature Space Optimization (FSO) and Separability and Threshold (SEaTH).

This workflow was applied in the classification of benthic habitats Manicani Island, Guiuan, Eastern Samar in the Philippines. Accuracies ranging from 77-83% were achieved. Nearest Neighbor Classification attained the highest accuracy and Hierarchical Classification had the lowest. The process presented in this study shows that LiDAR data and its derivatives can be used in analyzing the seafloor and creating benthic habitat maps, which can be helpful in managing coastal environment.

PP. 3: Mapping of Dugong Feeding Trails in Seagrass Beds of Pujada and Mayo Bays, City of Mati, Davao Oriental

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Large marine animals such as dugongs are legally protected but so little information regarding their occurrences and behavior has been gathered. This study aims to map out the dugong feeding trails in seagrass beds of Pujada and Mayo Bays, City of Mati. The new and old feeding trails were monitored last October 2013 until June of 2014. Four study sites were established namely; Sitio Taganilao and Sitio Manguijay of Pujada Bay and *Amihan* and *Kanakbai* of Mayo Bay.

A 25x25m quadrat was established, two in every site in the place where dugong feeding trail concentrations are greater. The seagrass recorded in the sites are; *Halophila ovalis, Cymodocea rotundata, Thalassia hemprichii* and *Enhalus acoroides.*

Twenty-six (26) feeding trails were recorded for Pujada Bay (Sitio Taganilao and Sitio Manguijay) with old (16) and new trails (10). Mayo Bay has 54 feeding trails recorded for both *Amihan* and *Kanakbai* area with old (29) and new trails (25). A total of 70 dugong feedings trails identified for both bays.

The mean length of Dugong trails recorded in Pujada Bay is noted to be longer and narrower for both Sitios Taganilao (5.25m) and Manguijay (6.95m) compared to the feeding trails recorded in Mayo Bay that has a mean length of 2.27m in *Amihan* and *Kanakbai* - 1.71m.

Frequency of dugong feeding trails identified in Pujada and Mayo Bays showed that dugong individuals present in the area is significantly high that suggested that both bays were dugong feeding areas. These marine mammals were observed as resident individuals that need protection and conservation including their habitat. Extensive information, education and communication (IEC) drive can be used to enhance the awareness of Local Government Units (LGU) on the presence of dugongs and to enforce strictly the existing laws regulation to ensure protection and conservation both in local and global scale.

PP. 4: Community-based Mangrove Rehabilitation and Enhancement Project in Davao Oriental

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The project is collaborative efforts of BFAR-CHED involving local SUCs in the implementation of the Philippine National Aquasilviculture Program (PNAP) in the Province of Davao Oriental. It aims to intensify the mangrove resource rehabilitation, conservation, protection and to promote alternative livelihood among fisherfolk. This will also ensure sustainable development, food security and reduce poverty in the coastal areas of Davao Oriental. This project was implemented from 2012-2015, which focuses on the 7 municipalities and 1 City of Davao Oriental.

A total of 300 hectares in the project sites were planted with 714,612 hills of mangroves by 803 beneficiaries. The common species of *Rhizophora, Avicennia*, *Sonneratia,* and *Nypa fruticans* that thrive in the areas were planted.

Monitoring and evaluation of the rehabilitated mangrove area in all of the municipalities within the province was conducted. Percentage of survival of mangrove rehabilitation was about 53.95% and 58.96% for mangrove enhancement after 1 year (2012-2013). Additional areas were planted in 2014 with 61% of survival. However, an evaluation on selected project sites was done in 2015 to assess the status of mangrove enhancement after the project ends in 2014. Estimated percentage of survival of mangrove rehabilitation and enhancement in areas verified ranged only from 10-15% in 2015 out of the 61% survival percentage recorded in 2014.

During the project implementation, biological factors (animal/insect herbivory) and ecological factors (climate change, typhoons, & flashfloods) were noted. Other anthropogenic issues were also observed such as informal settlers which contribute to waste disposal within mangrove areas; conversion of mangroves into fishpond and destructive fishing or gleaning activities. These constraints affect the growth and survival of planted mangroves in the project sites of Davao Oriental.

Conservation and management of the remaining mangrove forest in Davao Oriental must be strengthened through community-based coordination and advocacy for sustainable resources.

SESSION 4: THE SEAGRASS AND MANGROVE FACTOR IN COMMUNITY RESILIENCE

OP. 1: (Plenary Paper)

Seagrass Response to Stress as a Major Determinant of Ecosystem Resilience in Philippine Coastal Environment

Miguel D. Fortes, PhD

Marine Science Institute, College of Science, University of the Philippines, Diliman, Quezon City

A collaborative Philippine-Japan research project was undertaken from 2010 to 2015. It was anchored on formal and informal collaboration with partners. The project aimed to establish, among others, a robust seagrass science in order to enhance resilience on the part of both the ecosystem and its dependent coastal communities in mitigating and adapting to the impacts of local environmental disturbances and climate variability. This was done principally by establishing an effective link between science and policy in implementing local seagrass conservation and capacity building in identifying and sustainably utilizing the ecosystem services.

The project activities were categorized under 6 components: geochemistry, remote sensing GIS and modeling, marine ecosystems and services, public engagement, capacity building, and policy and institutional reform. Data were analyzed on the basis of pressures, resilience, status and conditions and trends. The products of the activities include: baselines, models, maps of nutrient fluxes; hydrodynamics; seagrass structure, connectivity; economic scenarios (on fish cage cultures); formal agreements with LGUs, NGOs; Integrated Decision Support System (IDSS); and training, scholarships; regional/national symposia; workshops, Focus Group Discussions', journal publications, a book, brochures, posters, a video, media and CCTV footages. Indicators of success include: enhanced ordinances, actual physical and financial support to project needs, positive change in attitude towards science-based conservation, higher attendance in follow-up activities, 'more intelligent' questions, inputs on the part of participants in later discussions, and post-project implementation and pursuance of recommendations at the study sites.

OP. 2: Rehabilitation of Mangrove Forest Impacted by Typhoon Yolanda (Haiyan) in Busuanga and Culion, Palawan by Communities

Archie F. Espinosa, Reynante V. Ramilo, Danica Amanda D. Lopez,
Community Centred Conservation (C3) - Philippines

In response to the vital need to rehabilitate areas affected by super Typhoon Yolanda (international name Haiyan), C3 Philippines in partnership with the Smart Communication Inc. initiated the implementation of the project "Rehabilitation of Mangrove Forest Impacted by Typhoon Yolanda in Busuanga and Culion, Palawan by Communities." Mangroves in Palawan are considered as part of the last frontiers for mangroves in the country, and rehabilitation of existing or former mangrove forest areas continue to be part of the national agenda for protecting the various ecosystem services they provide. The following communities in Busuanga and Culion were included as part of the project: Brgy. Quezon and the Balik Calawit Movement (BCM) Tagbanua tribe in Busuanga Municipality, and Brgy. Galoc in Culion Municipality.

The project objectives are being realized through close collaboration and partnerships with the Local Government Unit of Busuanga and various organized community volunteer groups of selected barangays in Busuanga, Palawan. These partners are the key actors in coastal ecosystem management in the municipality. The primary objectives of this project include not only enhancing the mangrove forest cover of Busuanga and Culion, but also to capacitate these key actors in coastal ecosystem management, specifically for mangroves, in the municipality. Community-managed mangrove nurseries were established, with local partners capacitated and trained in nursery and mangrove maintenance, gathering of wildlings, planting and monitoring. The community-managed nurseries are targeted to be self-sustaining until after the project. Project success indicators can be measured based on the degree of increase in forest cover and area rehabilitated at the end of project implementation. This is one of the main components of this project since it will spell out the vegetative improvement and enhancement of the current state of mangrove forest in the island.

OP. 3: Strengthening Disaster Preparedness through Critical Habitat Conservation in Guimaras Province Philippines

Rose Jane N. Sablon
Guimaras Environment and Natural Resources Office, Jordan Guimaras, 5045

The highlights of a Philippine (Guimaras) – Korea (Yeosu) Project Phase 2 (2013-2016) are presented. The project aims primarily to protect the lives and property of Guimaras residents through protection of seagrass and mangrove ecosystems and especially their associated fisheries resources. This goal is attained by applying the outcomes of the assessment of the status and potentials for development of these critical and vulnerable habitats.

The project consists of three components: mapping of the habitats and formulation of their management plans building the capacity of provincial officials, residents, and the youth and joint research on the ecosystem services of seagrass and mangroves. The outputs of the activities include: habitat maps of the study sites, baselines, management plans for the three Marine

Protected Areas with facilities including guard house and foot-bridges, patrol boats, and signboards. Success indicators of the project are: adopted and implemented MPA management plans, enhanced ordinances, active participation of the stakeholders, functional management board, financial and technical support to the project needs.

OP. 4: The Seagrass Bioshield Project: The Malita Experience

Ruth S. Lucero[1], Miguel D. Fortes[2] and Monica Sarceda[2]

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The Seagrass Bioshield Project (SBP) implemented in Malita focused on seagrass habitat and trophic dynamics assessment involving preliminary determination of siltation gradients, biodiversity, plant biomass and growth rate in the seagrass beds and occurrence of dugongs in relation to various parameters (e.g. presence of picnickers, time of the day). Salinity levels at the seagrass beds of Malita within Davao Gulf were always quite higher compared to that of Mati where stations are facing the Pacific Ocean.

Social and capability building component of the project focusing on community resilience has been done through a series of Focused Group Discussion (FGDs) and workshops. The FGDs and workshops were avenues for the project staff, academe, stakeholders and community to share ideas and exchange information. Highlights of the FGDs and workshops include strengthening of the research capability of the academe and enhancing awareness of the community, LGU and development sector on how the SBP outputs can be used to build capacity in decision-making and in utilizing more efficiently the ecosystems' goods and services, while adapting to environmental changes.

The results of the SBP have indicated collective response of the ecosystem to act as bioshield, sustaining the productivity of the communities from the negative impacts from climate change. However, in Malita, the establishment of a huge Coal Fired Power Plant (CFPP) in the vicinity of the dugong habitat and how to bring about parallelism between development and conservation remain the greatest challenge at hand.

PP. 1: Ecosystem-based Adaptation to Climate Change in the Verde Island Passage, Philippines

Zarena B. Mercado
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Verde Island Passage is located within the Sulu-Sulawesi Seascape and is part of the Coral Triangle. It is an area considered to be the center of the world's marine biodiversity. VIP's population of over 1.7 million people, which is expected to grow rapidly within the next decade, depends heavily on marine resources for livelihood, including fishing, aquaculture, and tourism. As climate change intensifies, the existing problems of overfishing and coastal erosion will also become more pronounced.

As a response to possible effects of climate change in the region, CI-Philippines has initiated ecosystem-based adaptation (EbA) options in VIP. EbA is a concept, which capitalizes on the ability of natural systems to assist in human adaptation to climate change. Coastal protection through mangrove reforestation was initiated as an EbA option in coastal areas vulnerable to increased storm events and their associated effects. To build the socioeconomic adaptive capacity of affected communities, income diversification initiatives were also implemented.

CONFERENCE PROGRAM

Time	Activities
	Day 1, Thursday, 26 May 2016 **Opening, Plenaries, Presentations, Panel Discussion, & Poster Session**
Time	**Activities**
0800-0930	Registration & Ingress of Posters (With running video as guests are seated)
0930-0940	Inspirational Welcome Address by Dr. Laura T. David, Professor, Marine Science Institute CSUP
0940-0950	Opening Address by Dr. Miguel D. Fortes, Project Coordinator & Principal Organizer, Marine Science Institute CSUP
0950-1010	BREAK & PHOTO-OP
1010-1200	**SESSION 1** **Seagrass & Mangrove Ecological Dynamics**
1010-1030	**Plenary Paper**: *"Marginalizing mangroves and seagrasses amidst space-use conflict in the marine intertidal zone"* (Rene N. Rollon, IESM, UP)
1030-1045	*"An Agent-Based Model of Post-Disaster Mangrove Forest Regrowth"* (Vena Pearl Bongolan, Franklin David Ang, J. Stephen D.V. Mariano)
1045-1100	*"The overlap of small-scale fishing activities and dugong (Dugong dugon) critical habitats in selected communities of Busuanga, Palawan"* (Danica D. Lopez)
1100-1115	*"Transplantation Seagrass Method by Using Crowbar: Simple, Easy, and Cheap"* (Wawan Kiswara)
1115-1130	*"Fate of existing Rhizophora plantations against Super-Typhoons: mass mortality beyond age-thresholds"* (Villamayor, Betty May R., Rollon, Rene N., Samson, Maricar S., Albano, Giannina Marie A., Primavera, Jurgennne H.)
1130-1200	Poster Session
1200-1330	LUNCH BREAK
1330-1430	**SESSION 2** **Seagrass & Mangroves as 'Blue Carbon' Ecosystems**
1330-1350	**Plenary Paper**: *"Prospects and uncertainties in carbon sequestration potential of mangroves and seagrass in the Philippines"* (Severino Salmo III, DES-SSE, AdMU)
1350-1405	*"Framing the future of seagrass blue carbon studies in the Philippines"* (Miguel D. Fortes, Marine Science Institute, CSUP)
1405-1430	Poster Session
1430-1630	**Panel Discussion (PD) 1**: "Sustaining the Services of Seagrasses & Mangroves"
	Day 2, Friday, 27 May 2016 **Plenaries, Presentations, Panel Discussion, Summation & Closing**
Time	**Activities**
0830-0930	Registration (With running video as guests are seated)
0930-0940	"Highlights of Day 1" (Severino Salmo III)
0940-1200	**SESSION 3** **Ecosystem Services & Improved Coastal Conservation**
0940-1000	**Plenary Paper:** *"Conserving mangroves and seagrass and enhancing their ecological services through community, science, and technology partnership"*

	(Ariel C. Blanco, DGE-CE, UPD)
1000-1015	*"A Study on the Utilization of LiDAR data in Monitoring the Extent of Mangrove Reforestation and its Impact on Selected Coastal Barangays of Zamboanga City"* (Ahmed J. Baldomero, Dominic Rey E. Acuña, Chrazel Dice M. Magpayo, Felix M. Jusay III, and Geoffrey M. Fabian)
1015-1030	*"Mangrove Forest Extent Mapping in Southwestern Luzon Using 2015 Landsat Imagery"* (Al Jayson G. Songcuan, Alvin B. Baloloy, Ariel C. Blanco)
1030-1045	*"ICM Mechanisms Promote Multi-Stakeholder Critical Habitat Conservation in Guimaras Island, Philippines*" (Neil Catalan)
1045-1100	*"Drawbacks of Successful Mangrove Rehabilitation Schemes: Lessons Learned from the Renowned Mangrove Plantations"* (Abner Barnuevo, Takashi Asaeda, Kelum Sanjay, Yoshikazu Kanesaka, Miguel Fortes)
1100-1115	*"Community Based Mangrove Resource Management and Aquasilviculture: A Coastal Conservation and Livelihood Project in Davao del Sur"* (Irvin C. Generalao, Augie E. Fuentes, Marlyn B. Llameg, Michelle M. Elemino, Pedro M. Avenido, Godofredo F. Lubat Jr., John Paul R. Pacyao, Regie D. Patagoc)
1115-1200	Poster Session
1200-1330	LUNCH BREAK
1330-1415	**SESSION 4** **The Seagrass & Mangrove Factor in Community Resilience**
1330-1345	**Plenary Speaker**: "*Seagrass & Mangrove Factor in Community Resilience"* (Miguel D. Fortes, MSI, CSUP)
1345-1400	*"Rehabilitation of Mangrove Forest Impacted by Typhoon Yolanda (Haiyan) in Busuanga and Culion, Palawan by Communities"* (Archie F. Espinosa, Reynante V. Ramilo, Danica Amanda D. Lopez)
1400-1415	*"Strengthening Disaster Preparedness through Critical Habitat Conservation in Guimaras Province Philippines"* (Rose Jane N. Sablon)
1415-1430	*"The Seagrass-Bioshield Project: The Malita, Davao Occidental, Philippines"* (Ruth S. Lucero, Miguel D. Fortes and Monica Sarceda)
1430-1630	**Panel Discussion (PD) 2**: "Developing the Framework of a National Blue Carbon Strategy"
1630-1645	Summation
1645-1700	Closing & Egress of Posters

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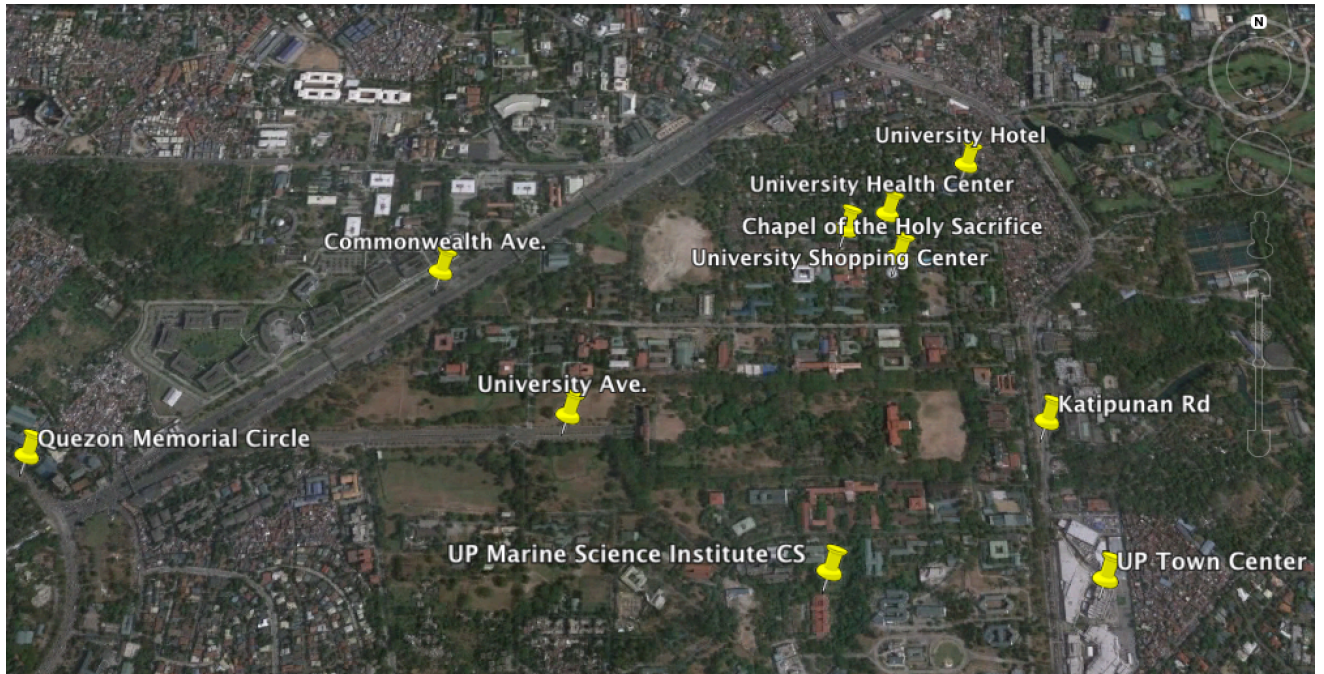
Places of particular interest for participants of the conference

THE CONFERENCE STREAMER

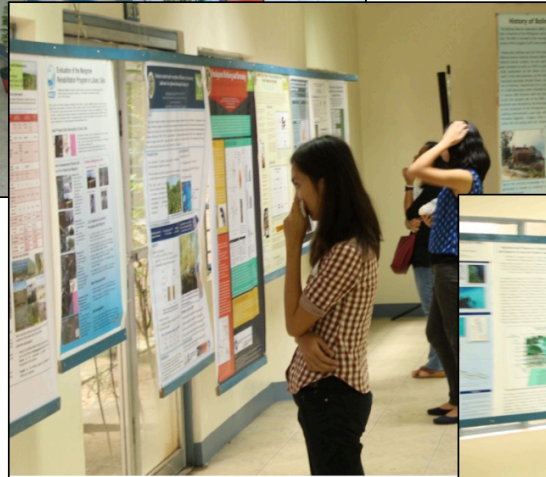# Welcome and Opening Addresses

Welcome Address
Dr. L.T. David
Deputy Director for Instruction
UPMSI

Opening Address
Dr. M.D. Fortes
APN SMBP & Conference Coordinator

Poster Session

Participants of the First National Seagrass-Mangrove Bioshield Conference
Marine Science Institute CS, University of the Philippines
26-27 May 2016