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AN INNOVATIVE GOVERNANCE STRUCTURE FOR THE MANAGEMENT OF THE UNIQUE SOUTH CHINA SEA LARGE MARINE ECOSYSTEM (LME)

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Abstract
A comprehensive maritime policy that can be effectively monitored to achieve a multi lateral agreement amongst South China Sea LME countries is imperative. South China Sea LME areas comprise multifaceted ecosystems and are rich with marine biodiversity. It became the largest aquarium in the world due to her strategic location and unique natural oceanic phenomenon. This paper proposes an innovative governance structure specifically designed towards stronger cooperation among South China Sea LME member countries towards sustainable management of these areas. It promotes a new direction to enhance the potency of the South China Sea LME Commission. A new body for the management, exploitation, exploration and protection of the South China Sea LME areas based on the novel method of cluster strategy has been introduced. This study also proposed to develop the strategy and framework that act as a tool kit for policy makers, regulatory bodies and vested stakeholders. This is to support the maritime communities in progressing towards a more sustainable development in exploring, exploiting and protecting the future resources in the South China Sea LME areas.

Keywords-- Sustainability; Governance Structure; South China Sea LME; Cluster Strategy

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INTRODUCTION

The future is uncertain for the world's large marine ecosystems (LME). These focus narrowly on ocean zones which produced nearly 95% of useable marine biomass, and these are becoming increasingly stressed by natural and anthropogenic changes. The potential for negative consequences on global ecologies and economies have aroused major national and international concern. This paper is an initiative to update on the status quo of large marine ecosystems, representing a multidisciplinary effort to develop a more holistic approach to the research, monitoring and management of South China Sea LME particularly on her marine resources.

Marine ecosystems and their contributing freshwater basins are transboundary in nature by virtue of interconnected currents, pollution, movement and migration of living marine resources. Eighty percent of the global marine fisheries catch comes from 64 Large Marine Ecosystems (LMEs) delineated along the continental shelves and coastal currents, that represent multi-country ecosystem-based management units for reversing fisheries depletion (Duda & Sherman, 2002).

The lack of attention to effective policy, legal, institutional reform, low priority given to public investments, and lack of enforcement of various regulations now place at risk not only coastal and South China Sea LME but also maritime communities that depend on them for economic security and social stability. In addition, traditional sector-by-sector approaches to economic development in the South China Sea states have created many issues in the maritime ecosystem. Established environment programs should not incorporate the policies and programs of other economic sectors that can operate at multiple scales and harness stakeholder support for cluster management in synchrony with the improved management of other sectors in the South China Sea LME.

SOUTH CHINA SEA UNIQUE MARINE ECOSYSTEM ENVIRONMENT

The South China Sea currently exhibits more than 250 small islands, atolls, reefs, shoals, skerries (small rocky islands) and sandbars, most of which are uninhabited. These fall into the categories of fully submerged, tidally submerged and fully emergent. These island landforms can be classified into a few major archipelagos, notable of which are the Macclesfield Bank, Spratly Islands, Pratas Islands, Paracel Islands and Scarborough Shoal.

The Spratly Islands covers an extent of about 720,000 square kilometres and comprises approximately 175 distinct insular landforms. The largest island is Taiping, with a length of 1.3 kilometres and maximum elevation of 3.8 metres. However, the largest individual feature in the Spratly regime is located at the northeast of the Spratly, 100 kilometre long seamount termed Reed Bank, which is alienated away from the Philippines island of Palawan by the Palawan Trench.

The South China Sea Large Marine Ecosystem (LME) is characterized by its tropical climate (see **Figure 1**). It is located in a strategic location and becomes a large natural 'aquarium' which is insignificantly affected by large ocean circulation and hurricane but open to the tsunami impact due to the earthquakes and submarine slides located in the Manila trench.

Figure 1. South China Sea Large Marine Ecosystem
Source: Adapted and modification from National Oceanic and Atmospheric Administration (NOAA) and http://www.oceanweather.com/data/. Accessed 06 June, 2011.

Vietnam, China, Taiwan, the Philippines, Malaysia, Thailand, Indonesia and Cambodia are the eight countries bordering the South China Sea LME. Large ocean circulation is irrelevant in this areas due to the barriers provided by neighboring countries such as Taiwan, Philippines and Indonesia (see **Figure 2**).

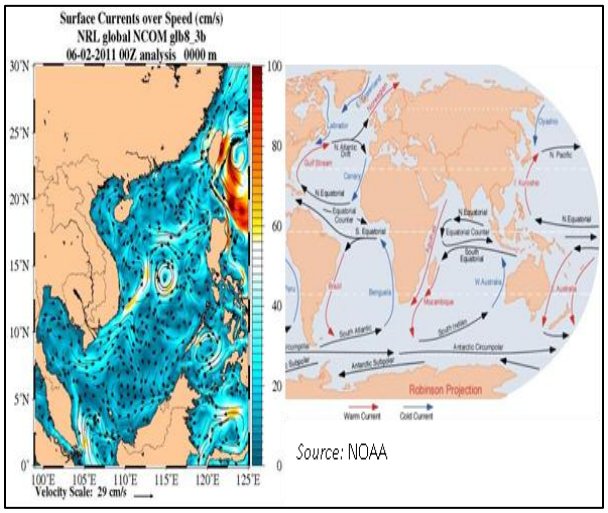

Figure 2. Large Ocean Circulation

In the past 100 years there has been no major earthquake or tsunamis incident recorded in this region. However, the Manila Trench which located along the Manila trench (see **Figure 1**) is a possible source of tsunamis and it represents a potentially large tsunamigenic earthquake and submarine landslides source within the South China Sea. The possible most effected countries in the South China Sea by tsunamis due to the major earthquakes and submarine landslides in the South China Sea are mainland China, Hong Kong, Hainan Island, Vietnam and Philippines. This is because these areas are close to the deeper basin of the South China Sea LME.

The South-Western Corner of the South China Sea become shallower. Hence the possibility that any tsunami wave heights are attenuated and reduced even further in shallower waters. Support funding and research collaboration among South China

Sea LME neighboring countries are vital to quantify the tsunami hazard to vulnerable communities, ports and infrastructure along these coastlines as well as an impact to the marine ecosystem. The information and coordination should be shared and supported among South China Sea LME states for development of an early warning system for management of the potential hazard in the South China Sea LME. The South China Sea LME states should also initiate collaboration and funding mechanism to enhance human and institutional capacity, environmental laws and regulations leading to the setting of priorities for action in coordinating and effective managing of potential hazard and conflicts in the South China Sea LME.

There were large increase of biomass from year 1995 to 2004, between 0.97 to 1.27 MT (biomas yield) and fisheries catch proved to be in abundance within the South China Sea LME. From the year 2000 to 2004 a record shows 0.82 to 1.16 MT (FOA, 2005).Thus, it is an indicator of high density and diversity of marine ecosystem in the South China Sea LME. South China Sea LME also provides the earth's energy balance due to its location near to the equator. The two main features of the earth's energy balance are:

- there is a net gain of solar energy in the tropical latitudes and a net loss towards the poles, and
- tropical latitudes receive more of the sun's energy than polar regions

Input into the global heat budget comes in the form of short-wave solar energy and this is called insolation. Only 51% of this insolation reaches and is absorbed by the earth's surface. The rest is absorbed by water vapor, dust and clouds, or is reflected by the earth's surface and scattered by particles in the air (the

Albedoeffect). The atmosphere is largely heated from below, by long-wave terrestrial radiation from the earth's surface.

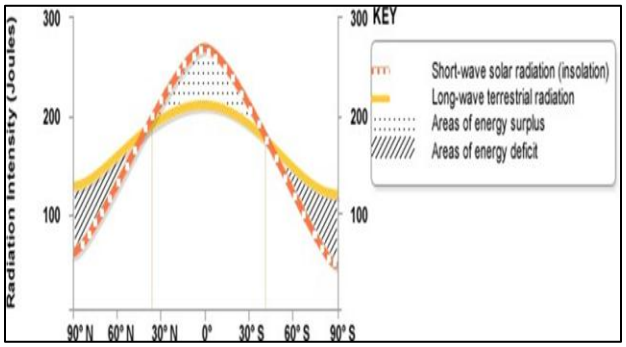

Figure 3. Surplus and Deficit of Energy between 35N and 35S

There is a surplus of energy between 35N and 35S. In this region, incoming insolation exceeds outgoing radiation. There is an energy deficit between 35N and the North Pole, and between 35S and the South Pole. The outgoing radiation exceeds incoming insolation. Insolation rises sharply from 50 joules at the poles to 275 joules at the equator. Terrestrial radiation varies less, from 120 joules at the poles to 200 joules at the equator.

The most abundant form of energy on Earth is heat and it is about 70% of all energy forms, and most of them are stored in the upper layers of deep oceans across the equatorial regions. The heat could be extracted and converted into electric power, or if not, hydrogen fuel. Hydrogen will be fast becoming the most dominant energy carrier by the middle of 21st Century. Other energy carriers including electricity, oil, natural gas, and coal will be less significant. Energy is transferred from the low-latitude energy *surplus* areas to the high-latitude energy *deficit* areas by atmospheric circulation. If there was no atmospheric circulation, the low latitudes would get hotter and the high latitudes will be colder. Fig. 3 illustrated that the tropical areas (South China Sea LME) get more insolation than Polar Regions. Thus, there is excellent prospect for harvesting solar energy or ocean thermal energy in these areas and could become a new growth economy or become a blue economy for South China Sea LME states in the near future.

Productivity

A habitat in the South China Sea LME includes seagrass beds, coral reefs and soft-bottom communities. The South China Sea is a biologically diverse marine ecosystem. It is considered a Class II, moderately high productivity ecosystem based on SeaWiFS global primary productivity estimates to produce between 150 – 300 grams of carbon per square meter per year (Craknell, 2011). High productivity levels are found in gulfs, along the coast, and in reef and seagrass areas, common in the Philippines portion of the South China Sea LME.

The Food and Agriculture Organization (FAO) 10-year trend shows a steady increase in total catch, from six million tons in 1990 to 13.5 million tons in 1999. The average level is 10 million tons. The greater marine biodiversity of tropical regions is reflected in catch composition. There is also a high percentage for miscellaneous coastal fishes and pelagic fishes such as tuna, yellow fin, big eye and skipjack, herrings, sardines and anchovies (see FAO, 2003; 2005).

Pollution and Ecosystem Health

Ecosystem health is affected by coastal and economic development with 270 million people or five percent of the world's population live in the coastal areas of the South China Sea LME. This population is expected to double in the next three decades. The main environmental threats are sewage pollution, destructive fishing practices, overfishing, the destruction of mangrove forests, coral reef degradation, and damage to sea grasses and wetlands. 65% of mangrove forests have lost to either shrimp farms, industrial areas or tourist resorts. The mangroves are chopped up for wood chips and firewood. Their disappearance on such a large scale has led to sediment erosion, water pollution, loss of biodiversity and a critical loss of nursery habitat for young fish.

Climate change and an increase in the sedimentation of the many major rivers flowing into the South China Sea LME are impacting corals. Collaboration research and funding from various agencies in the South China Sea LME states are crucial for supporting efforts to restore and protect these globally significant coral reefs, sea grass beds, mangroves and wetlands within this LME and its coast. New method and technology should be designed to improve the region's capacity to make sound environmental assessments through Geographic Information System (GIS).

Between 0.35 and 0.50 per cent of a tanker's cargo settles to the bottom of the tank during long sea voyages, and unscrupulous operators discharge this residue into the sea. Approximately 75,000 tonnes on a single voyage of a 250,000 DWT Bulk Carrier vessel could be discharged into the sea together with the ballast water. In South-East Asia this phenomenon results in major concentrations of ballast discharge at each end of the Malacca Straits, in the western Java Sea, west of Madura, off Balikpapan water, and off Brunei and Sabah water (Valencia, 1990). Furthermore, plumes of tank washings are generated along the two major tanker routes (**Figure 4**).

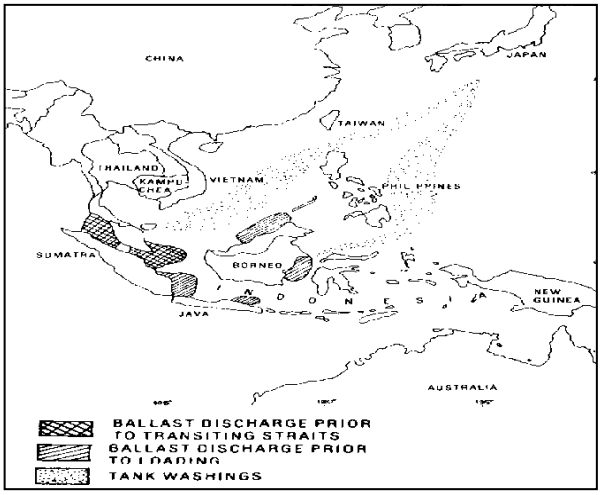

Figure 4. South-East Asia: Ballast and Tank Washings
Source: R. W. Hann, Jr. et al (1981), 'The Status of Oil Pollution and Oil Pollution Control in the Southeast Asian Region', Texas A&M University, April, p. 182 (Figure 5-25).

The introduction of invasive marine species into new environments by ships' ballast water attached to ships' hulls and via other vectors has been identified as one of the four greatest threats to the world's oceans. There are thousands of marine species that may be carried in ships' through a ship's ballast water intake ports and pumps. These include bacteria and other microbes, small invertebrates and the eggs, cysts and larvae of various species. The problem is compounded by the fact that virtually all-marine species have life cycles that include a planktonic stage or stages. These species will establish a reproductive population in the host environment. It may even become invasive, out-competing native species and multiplying into pest proportions.

Ballasting of ships is a necessary requirement for their safe operation when sailing empty to pick up a cargo, or with a light load, and it has been recognised that currently the only effective way to stop the spread of unwanted organisms is to prevent them being dumped in foreign ports.

The South China Sea LME marine ecosystem shall be protected using regional and international instruments such as compliance with the IMO convention on ballast water management for ships (IMO, 2004), joint research on the water quality and development ballast water reception facilities among South China Sea States and monitoring procedures and enforcement regarding ballast water activities in the South China Sea LME (Ghani et al., 2019). Thus, the management and mechanisme to execute this instruments should be developed and established by South China Sea states to sustainable manage and protect the South China Sea LME marine flora and fauna for the long term.

Socioeconomics

The South China Sea LME contributes to millions of people engaged in fisheries, trade, tourism, industry, and oil exploration and exploitation. The economic development of the region has intensified the competition for marine resources especially fisheries resources in the South China Sea LME, and has led to overfishing and dispute of marine boundary. The coastal and estuarine areas off of Vietnam water and Cambodia water are historically very productive from a fisheries perspective. Vietnam's demersal resources were exploited primarily by Taiwanese and Chinese vessels. The Northwestern coast of the Philippines is a soft-bottom area fished intensively by trawlers (Silvestre et al., 1989). The deep shelf areas of the South China Sea are fished by Taiwanese vessels (Yeh, 1981).

The LME accordingly is severely impacted in terms of overfishing, with severe socioeconomic and community consequences. The ongoing depletion of the LME's marine resources will adversely affect the region's economy. The area's rapid economic development and its population growth are causing significant ecological damage in coastal and marine areas.

The South China Sea LME is the world's second busiest international sea lane. The current South China Sea activity will form the cornerstone for future activities in gas and especially deepwater oil in the South China Sea LME. It is already a proven and mature hydrocarbon basin covering a larger area in the South China Sea LME (see **Figure 5**).

Figure 5. Prospect Oil and Gas in the South China Sea LME Source: http://www.harvestnr.com/operations/china.html. Assessed 06 June, 2011.

Eight nations (Cambodia, China, Taiwan, Indonesia, Malaysia, Philippines, Thailand and Vietnam) are involved in the governance of the South China Sea LME, sharing concerns about the marine environment and an awareness on the importance of the Sea as a source of protein and energy for the growing coastal populations.

Western and Soviet efforts have always dominated oceanographic research in South-East Asia (Valencia and Evering, 1983). Notwithstanding the consent regime, it is likely that external efforts will continue to dominate marine science exploration in South East Asia particularly in the South China Sea LME, although now under the external support/form of international institutions and 'cooperation' with or 'assistance' to indigenous institutions. This subterfuge is assisted by the fact that the numerous international organizations with marine science interests operating in the region are not indigenously derived, developed, funded, or directed and comprise both extra-ASEAN and extra-South China Sea states. Thus, mechanism to integrate and enhance the maritime management and oceanographic research among South China Sea states should be established towards a goal of self-financing the oceanographic research, assessment and management of the South China Sea LME.

Governance

The entire region in the South China Sea states is experiencing a phase of rapid economic development and population growth. This has sharpened conflicts within governments such as China. Moreover, several countries have contending claims to large areas of the South China Sea, leading to political tensions among them. The claims are about the status of the South China Sea LME which included Paracel Islands and the Spratly Islands, consisting of potentially resources-rich area. However, mechanism to collaborate in the monitoring and protection of the marine environment through partnership in Environmental Management in the Seas of East Asia (PEMSEA), and Coral Triangle Iniative-Coral Reefs, Fisheries and Food Security should become a policy tool and provide the basis for a political resolution among Asosiation of Southeast Asian Nations (ASEAN).

Although hydrocarbon potential has been the main focus of the disputants until now, fisheries and other marine resources, tsunamis information, navigational safety, and strategic and environmental concerns may become equally critical issues in the future.

AN INNOVATIVE GOVERNANCE MODULE INDICATORS

The cluster approach to manage the South China Sea LME should be adopted in the establishment of the novel South China Sea LME Commission and managing as multinational units in order to sustain the resources. The concept of clusters was related to the "competitiveness" of industries and of nations as described below:

Clusters are a geographically proximate group of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities. Clusters encompass an array of linked industries and other entities important to competition . . . including governmental and other institutions – such as universities, standard setting agencies, think tanks, vocational training providers and trade associations (Porter 1998).

Fundamentally a cluster is an internationally recognizable competitive advantage in a particular sector of industry (Porter, 1998), for examples, the maritime service cluster in London explained by Fisher Association (Fisher, 2004) and the high technology cluster in the Silicon Valley (Gambardella, 2004). In

contrast, approaches such as integrated water resources management, integrated ocean and coastal area management (Cicin-Sain, 1993), and marine spatial planning (Douvere, 2008; Douvere and Charles, 2009) are mainly used for planning activities to ensure the marine ecosystem are sustained in the future. Recent study revealed that the conversion of the maritime industry policy development and implementation from fragmented (sectoral) approaches toward centralised (Cluster Strategy) approaches has shown a very significant success in its implementation process (Cho, 2006).

Roelandt et al. (1999) have shown that, the cluster strategy may encompass intensive links and alliances with various institutions such as universities, research institutions, public authorities, consumer organizations, and so on. Many scholars define and recommend integrated oceans policy that is the opposite of sectoral management for ocean governance (Juda, 1999; Wescott, 2000; Underdal, 1980; Cicin-Sain, 1993). The international and/or national efforts to new approaches to ocean governance have led the US, Canada (Department of Fisheries and Oceans), Australia (Australian Oceans Policy) and Korea (Ministry of Maritime Affairs and Fisheries) to establish integrated oceans policy.

The Oceans Act of 2000 of US and the Report of US Commission on Ocean Policy, Australia's Oceans Policy, the Canada's 1997 Oceans Act and Canada's Oceans Strategy (COS) and the Korea's Marine Development Basic Act (MDBA, Law No. 3983, 1987) results from the need to strengthen ocean governance. The introduction of new concepts, such as "sustainable development" and "integrated management," into marine environmental management has advanced the changes in the nature and scope of marine biosphere politics (Lee, 1995; Abodher et al., 2018).

The establishment of the commission should consists of scientists, stakeholders, resource managers, and multisectoral ministerial representatives (e.g. fisheries, mining, maritime industry, energy, tourism, environment) from the bordering countries who will share their knowledge and understanding of the South China Sea LME in managing transboundary environmental and resource issues including recovering and sustaining fish stocks, mitigating effects of offshore mining, and oil and gas production based on the cluster approach, mariculture, shippin, and transport, energy production, tourism and mining, and improving the condition of degraded habitats.The Commission should be advanced in the understanding of the physical and biological drivers of change through research and assessment actions that will support management actions for protecting and sustaining the highly valued goods and services of the South China Sea LME.

The objective is to improve policy decision making at the international, national and local levels, linking expertise, research and good practices in diagnosing and equalising any differences in the management of the South China Sea LME areas. Nations approach these activities from different perspectives, partly dependent on their existing infrastructure, and their approach to manage the South China Sea LME areas (see **Table 1**).

Table 1. Activity in the South China Sea LME

Ecosystem Management	Maintenance of Law and Order	Safety of Navigation and Transit	Protection for the Environment
Ecosystem management is a key in LME activity. Many nations have system of licenses and quotas to generate revenue based on sustainable, efficient, equitable use of natural resources and preserve stocks and these laws need policing and controlling	Cooperation for controlling smuggling is a full time job for LME states requiring high manning and equipment levels. A joint venture to develop patrol vessels that can conduct operations efficiently will be of benefit.	Responsibility for maintaining the safety of navigation and transit in LME areas.	Protecting the environment is an important obligation for South China Sea LME status.

Source : Authors

The cluster strategic thinking is essential to be adopted in the policy to enhance the maritime communities toward an innovation and sustainable advantage (Othman, 2011). This would involve creating a new centralised entity comprising all South China Sea LME states placed under the jurisdiction of one single entity which could appear as a South China Sea LME Commission dealing with South China Sea LME affairs. The onus for policy integration shall then lie with this commission, well within the highest i.e. Prime Minister's Office for each state for easy constituency development on the maritime communities and sustainable management of the South China Sea LME as shown in **Figure 6.**

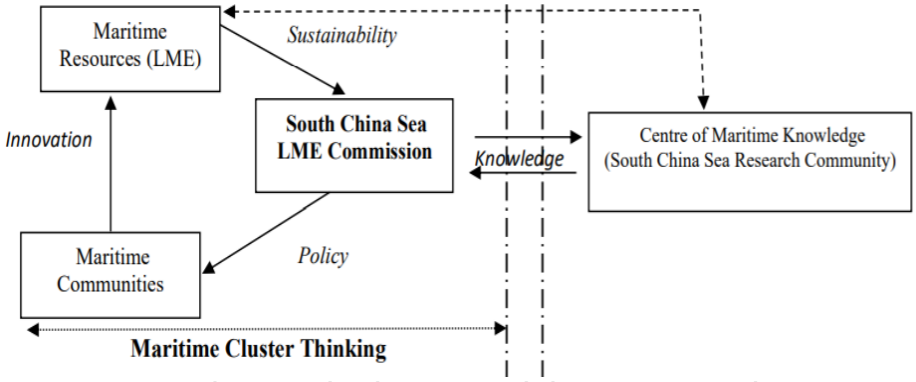

Figure 6. Integrated Ecosystem-based assessment and adaptive management planning actions
Source: Authors

As clearly shown in **Table 2**, a maritime community needs strong support and an effective policy which could be created by a South China Sea LME Commission. The presence of sufficient data on the South China Sea LME environment will make effective planning possible (South China Sea Research Community) in order to create the stimulating dynamics and innovation in the maritime communities which include a variety of suppliers /services, customers and competing businesses. This will lead to the maritime communities acquiring self strengthening growth, driven by competition, cooperation, learning and innovation to explore, exploit, conserve and manage the maritime resources in the South China Sea LME areas in a sustainable manner.

Table 2. Planning and Implementation of the Cluster-Based Management

No	Structure	Planning Actions	Implementation Actions	Objective
1	South China Sea Research Communities	Provides consensus priorities from analysis and ranking of maritime communities related resources issues, their environmental and socioeconomic impacts, immediate and root causes and possible remedies.	Productivity, ecosystem health, and socioeconomic indicators and assessments.	Toward the goal of self-financing of the assessment and
2	South China Sea LME Commission	Provides national and regional commitments to policy, legal and constitutional reforms and investments to remedy root causes of priority issues identified in South China Sea Research Community.	Governance indicators and assessments.	Cluster thinking assessment and adaptive management.

Source: Authors

In order to respond adaptively to enhance scientific information, socioeconomic considerations must be closely integrated with science findings by 'Center of Maritime Knowledge'. Both socioeconomic and governance indicators are used in the planning and implementation actions as summarized in **Table 2**. Within the context of cluster-based management, the integration of maritime meta-data and information for decision making is additive and integrated on annual assessment, move toward the goal of self-financing of the assessment and management process in the near future.

If the cluster policy succeeds in generating local synergies between maritime communities (maritime cluster), researchers and government institutions, it can have long-term benefits (David, 2009). Ideally, understanding the maritime cluster is a condition for any policy measure and is therefore a basic building block for the development of a coherent and effective management of the South China Sea LME. To explore and exploit the South China Sea LME areas effectively in a sustainable manner, South China Sea LME states need to establish a single maritime authority that will be able to focus on the South China Sea LME affairs.

In light of the discussion above, the recommendations below are in order; first, this paper recommends the establishment of the South China Sea LME Commission for coordinating and settlement of the entire issues related to the South China Sea LME. It should be able to function more effectively if it is equipped with powers to regulate and enforce its decisions. The member states should also be made to commit, comply and support its decisions. It should be an impartial arbiter free from the manipulations of any ASEAN country.

Another alternative is to employ bilateral or multilateral negotiation such as joint development agreement (JDA) among South China Sea LME members. Historically, there has been no single justification such as a law treaty, effective control or *uti possidetis* (territories inherited from colonial powers) has proven decisive in the maritime issues such as boundary dispute especially in the South China Sea LME. Therefore, joint development agreement may be seen as one of the best alternatives.

CONCLUSION

The management of South China Sea LME resources to facilitate sustainable economic development among member countries requires a cluster strategy based on sound information flow and a strong co-operation between maritime communities and research community. A strategic and significant role in achieving effective exploration, exploitation and protection of the South China Sea LME areas through the provision of a new proposal on the governance structure that is appropriate for coordinated and efficient decision making toward sustainable managing of the South China Sea LME areas. A poposed structure for maritime strategic cluster thinking via proper management of the information flow, an integrated and centralized maritime related knowledge and information to guide the external and internal maritime community's management, strategic incentives and effective policies can be introduced to manage the South China Sea LME areas. What is needed is the political will among member countries using effective instruments to effect a change to systems-centered thinking and planning for sustainable management of the South China Sea LME. Thus, with the effective instruments to manage the South China Sea LME toward sustainable economy development among members countries, the development of these areas in a sustainable manner can be done.

This novel governance strucure for management of the unique South China Sea Large Marine Ecosystem (LME) established a roadmap on how the South China Sea LME commision will manage and harness the opportunities offered by the South China Sea LME areas in sustainable manner for the equitable benefits of all, present and future while meeting the obligation to manage, protect and preserve the marine ecosystem. Thus, the birth and basis of a strong cooperation and an effective policy development among member countries could be realised and harmonised by the creation of a South China Sea LME Commission for managing this unique Large Marine Ecosystem and their future as a critical resources for the future generation.

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