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PROCEEDING

International Conference on Inland Fisheries

Palembang
September 2 - 4, 2014

Theme :

Contribute and Sustainable Use of Indonesian Aquatic Biodiversity to Contribute to Food Security

Research Institute for Inland Fisheries
Research Center for Fisheries Management and Conservation
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INTERNATIONAL CONFERENCE ON INLAND FISHERIES 2014

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2nd – 4th September 2014, Palembang

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PROCEEDING INTERNATIONAL CONFERENCE ON INLAND FISHERIES

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Research Institute For Inland Fisheries
Research Center for Fisheries Management and Conservation
Agency For Marine and Fisheries Research & Development
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PREFACE

Research Institute for Inland Fisheries (RIIF) of Research Center for Fisheries Management and Fish Resources Conservation (RCFMFRC) belong to Agency For Marine and Fisheries Research & Development under the Ministry of Marine Affairs and Fisheries of Republic Indonesia (MMAF-RI), has seriously considered the importance of inland waters for the people. Since 2004, The Research Institute for Inland Fisheries (RIIF) of Research Center for Fisheries Management and Fish Resources Conservation (RCFMFRC) has annually convened Indonesian Forum on Inland Waters in Palembang, South Sumatera. This year is the fourth International Conference on Inland Fisheries. The theme of the Conference is "*Conservation and Sustainable Use of Indonesian Inland Aquatic Biodiversity to Contribute to Food Security*". This conference is aimed at discussing the strategic contribution of related science for proper sustainable management of inland fisheries to contribute to food security.

This proceeding records the fully refereed papers presented at the conference. The conference topics:

- Ecosystem Approach Fisheries Management Initiative for Inland fisheries
- Inland biodiversity conservation management
- Integrated inland waters management: governance, structure and mechanism
- Economic and social benefits on inland waters
- Peat land management practices: rewetting, aquaculture and fisheries
- Inland fisheries and food security.

In this conference, there is about 50 of supporting papers submitted by the authors. All papers reviewed by the editors and 34 of supporting papers selected and published as a special publication in Proceeding of International Conference on Inland Fisheries. The selection of papers based on the content and quality of the papers.

We are grateful to all those who have contributed to the success of ICIF 2014. We hope that all participants and other interested readers benefit scientifically from proceedings and also find it stimulating in the process.

With our warmest regards,

The Organizing Committees
December, 2014
Palembang, Indonesia

ORGANIZING COMMITTEE'S REPORT

The honorable:
Dr. Sharief C. Sutarjo, Minister of Marine Affairs and Fisheries
Mr. Alex Noerdin, Governor of South Sumatera
Dr. Churnman Pongsri, Secretary General of SEAFDEC,
Prof. Dr. Sjarief Widjaja, Secretary General of MMAF,

Distinguished Guests,
Ladies and Gentlemen,

Assalamu'alaikum warohmatullahi wabarokatuh
Om Swastyastu
Good Morning

First of all, let me state our welcome, and thank you to all of you to attend this International Conference on Inland Capture Fisheries with the theme **Conservation and Sustainable Use of Indonesian Inland Aquatic Biodiversity to Contribute to Food Security.** This international conference is arranged in three days seminar and Musi Tour for sight-seeing Musi River.

This conference is organized by Research Institute for Inland Fisheries, supported by Government of South Sumatera Province, FAO, SEAFDEC, various Research Institute, and Universities. Our recent data show that 250 participants attend this conference from overseas (USA, FAO Roma, Mekong River Commission and all countries member of SEAFDEC) as well as from Indonesia. Once again we really appreciate your present.

Within three days activities, conference will present 6 keynote speakers, and 50 papers as research outcome and review will be presented by researcher and lecturer from various institution, and also from others profession related inland fisheries. At the end, it will be formulated into one comprehensive paper of policy recommendation for sustainable management of inland fisheries to contribute to food security.

Our distinguished guest,

Today, we are signing of National legitimacy Documents of SEAFDEC-IFRDMD. For the information that there are 4 departments under SEAFDEC, i.e. in Malaysia (Marine Fisheries Resources Development and Management Department), Singapore (Processing Department), Thailand (Training Department) and Philippines (Aquaculture Department).

Hopefully by developing Inland Fisheries Resources Development and Management Department (IFRDMD) of SEAFDEC will increase our commitment to support research and development of inland waters fisheries within ASEAN countries. Through research activity could prepare suitable management scheme and finally, the management manner can be applied to support ecological and economical sounds of resources utilization.

Ladies and gentlemen,

To all our partner, I truly appreciate for strong support. We hope this conference will be running based on what we have planned.

I kindly invite Governor of South Sumatera for welcoming remarks, Secretary General of SEAFDEC and for Minister of Marine Affairs and Fisheries to give opening remark of the conference and inauguration of SEAFDEC-IFRDMD.

Thank you.
Wassalamu'alaikum warohmatullahi wabarokatuh.

Chairman of Marine Affairs and Fisheries Research Agency

Dr. Achmad Poernomo

REMARKS
THE MINISTER OF MARINE AFFAIRS AND FISHERIES

Addressed by Secretary General of Minister of Marine Affairs and fisheries

Assalamualaikum wr. wb., good morning and best wishes to all of us,

1. Excellencies Ambassadors and Representatives of SEAFDEC Member Countries,
2. Excellency Dr. Chumnarn Pongsri, Secretary General of SEAFDEC,
3. Honorable Mr. Alex Nurdin, The Governor of South Sumatera Province,
4. Echelons 1 of the Ministry of Marine Affairs and Fisheries, Deputies and other Government Officials,
5. Distinguished Speakers and Participants from FAO, South East Asian Countries, and Japan,
6. Distinguished Delegates and Guests, Ladies and Gentlemen,

First of all, let us praise the Lord, the Almighty who has granted us the opportunity to be here today to attend the **Opening Ceremony of this important International Conference on Inland Capture Fisheries and Inauguration of SEAFDEC Inland Fishery Resources Development and Management Department (IFRDMD).**

I would also like to express my appreciation to all participants for attending these Events, especially to those who have made long journey to be here in Palembang, South Sumatera. I wish you all a very warm welcome to Palembang.

Distinguished guests, Ladies and Gentlemen,

Indonesian inland waters cover around 54 million Ha, of which 12 millions Ha consists of rivers and floodplains, 39 millions Ha of swamps and 2 millions Ha of lakes and other water bodies. They sustain the life of some parts of mega-biodiversity of Indonesia and it constitutes of at least 1,200 species of fishes (210 species kept as wet specimen in fish collection of Research Institute for Inland Fisheries Palembang), 200 species of shrimp and crabs, 315 species of mollusk, 200 species of amphibian, 100 species of reptiles and others. Due to this context, the scientific based management of Indonesian inland waters will be also very important to be addressed internationally.

Inland waters in Indonesia have played significant role in providing fisheries resources, either for capture fisheries activities or aquaculture or even for biodiversity both to support food security or ornamental fish busnises. Yearly, up to 1 million tons of fish can be potentially harvested from our inland waters; however current estimates show that this has only been utilized at the level of 50%. Inland waters have also become the source of living for more than 1 million people from the surrounding communities. This again reflects their important role in achieving the goal of fisheries development which is shared by three approaches, which are: pro poor, pro job and pro growth.

Inland water has been utilized by many sectors and stakeholders, where fisheries as one main sector. Their functions include as source of fresh water, biodiversity, food security and source of income for people. However, activities that have been done in utilizing inland waters resources could adversely affect the ecosystem itself such as pollution, sedimentation, extinction of several endemic biotas and changing structure of the water body.

Currently, it is estimated that ten big lakes in Indonesia are in such deteriorated state, that they have lost their capacity in supporting the economy of the surroundings. Serious efforts are now being taken to rehabilitate the lakes, and this is indeed a costly lesson and should not happen again in the future.

Ladies and Gentlemen,

As inland waters are also complex in nature, where its management should take into account not only for the fisheries resources, but also other available resources, through integrated involvement of all stakeholders. Therefore I am delighted to learn that experts, scientist, policy makers and other stakeholders to present in this three days conference for sharing information and knowledge on the management of inland waters. I believe that this is a good move to bridge the gap and build the communication among us, and at the end it is expected that a sound management measures can be formulated.

Honorable and Distinguished guests, Ladies and Gentlemen,

Recognizing the importance of inland fisheries, particularly to support food security and livelihood in the ASEAN region, Indonesia has proposed to establish a Regional Center for Inland Fisheries Development as part of SEAFDEC organization, namely Inland Fishery Resources Development and Management Department (IFRDMD). The proposal was supported by the ASEAN-SEAFDEC Member Countries during the 14th Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP) in November 2011, and the SEAFDEC Council Meeting during its 44th Meeting in April 2012.

The SEAFDEC - IFRDMD will act as a center that aims to assist SEAFDEC Member Countries in matters leading to the sustainable development and management of the inland fisheries resources in the region, by providing among others: a regional forum for consultation and cooperation in research and management of inland fisheries resources; scientific basis and appropriate guidelines; advice on management of inland fisheries resources, and; publication, dissemination and exchange information.

I am very happy that today we can witness the noteworthy moment of the process IFRDMD Inauguration by the Signing Document of Privileges Accorded to IFRDMD by Secretary General of Ministry of Marine Affairs and Fisheries of the Republic of Indonesia and its presentation to SEAFDEC Secretary General. I do hope with the establishment of IFRDMD, the regional needs and problems SEAFDEC Member Countries, associated with the responsibility to conserve and manage the inland fisheries for sustained development, and could be addressed more effectively.

Honorable and Distinguished guests, Ladies and Gentlemen,

I strongly believe that this conference will produce fruitful results where the presence of international and local experts will add to the weight of this conference.

Finally before concluding my remarks, I would like to take this opportunity to express my appreciation to Local Government, especially to the Governor of South Sumatera for the valuable support, especially the contribution for donating the land area of 1.6 hectares for IFRDMD building. I believe that our Research Institute here in Palembang will be a good partner in managing the inland waters in South Sumatera as well as other parts of Indonesia.

With the blessing of the Almighty God, **I declare that the International Conference on Inland Capture Fisheries is officially opened and the SEAFDEC – IFRDMD is institutionally inaugurated.** I hope all of you may enjoy your meeting and sightseeing in this beautiful Palembang City.

Thank you.
Wabillahi taufik wal hidayah, Wassalamu'alaikum Wr. Wb.

Palembang, September 2, 2014
On Behalf of the Minister of Marine Affairs and Fisheries,
Secretary General,

Prof. Ir. Sjarief Widjaya, Ph.D.,FRINA

WELCOMING REMARKS
GOVERNOR OF SOUTH SUMATRA PROVINCE

Palembang, 2 September 2014

Bismillahirrohmanirrohim
Assalamu'alaikum warohmatullahi wabarokatuh

The Honorable,
- Minister for Marine Affairs and Fisheries Republic of Indonesia, Sharif C. Sutarjo
- Secretary General of SEAFDEC, Dr. Chumnarn Pongsri
- Director General for Marine and Fisheries Research and Development, Dr. Achmad Poernomo;
- The First Ecelon Officials of Ministry of Marine Affairs and Fisheries Republic of Indonesia;
- Distinguished Speakers, Participants from FAO and ASEAN Member Countries and Japan, and all over Indonesia

Praise to the Almighty God for the blessing us with grace and health to be here today in this momentous occasion.
On behalf of the Government of South Sumatera I would like to espessially welcome His Excellency Minister for Marine Affairs and Fisheries Republic of Indonesia in Srivijaya Land.

Ladies and Gentlemen,
South Sumatra Province with its strategic location has over 7 Millions population, abundant mineral resources as well as vast energy and food resources, placing this province as 5th richest province in Indonesia.

These precious natural resources should be utilize in wise and sustainable manner in order to bring about people's welfare to the most as well as to drive advancement of the community itself.

Therefore the Government of South Sumatera is currently undertaking a mission to realize this visionary objective that is Prosperous, Advanced and Internationally Competitive South Sumatera.

Ladies and Gentlemen,
Speaking of Inland Waters, South Sumatera has an estimated 2,5 Million Ha of Inland Water bodies, consisting of Musi River and its subsidiaries, swams, lakes and other water bodies.

Inland waters function significantly as fresh water resources, habitats for various kind of plants and animals, and is important to support communities economy such as farming, aquacultures, as well as agriculture. Fisheries potential in 2013 alone yeilded 525,679,3 tonnes with the following details; 51.952 tonnes of inland capture fisheries, 44.531,8 tonnes of marine capture fisheries, and 429.195,5 tonnes of Aquaculture fisheries. In terms of biodiversity, The Musi River has over 221 fish species.

Excellencies, Ladies and Gentlemen,
In this opportunity I am delighted to welcome the establishment of the fifth Department of SEAFDEC, the Inland Fisheries Resources Development and Management Department, to joint the already existing four departments in Thailand, Singapore, Philipine and Malaysia. It is our honor that Palembang has been chosen as the seat of this department**.** I trully hope that the fishery potentials in South Sumatra and Indonesia and in ASEAN in general can be further developed

which may eventually contribute largely to the science and better management of Indonesian, ASEAN and the world Inland water bodies.

Ladies and Gentlemen,
Finally I would like to say have a nice and productive seminar, enjoy the breathtaking beauty and hospitality that South Sumatera can offer and off course, dont go home without taking a bite to some of our cullinary specialties. May God be with us all the way through the conclusion of the occasion.

Thank you.
Billahitaufik walhidayah
Wassalamu'alaikum warohmatullahi wabarokatuh

Governeor of Sumatera Selatan,

Ir. Alex Noerdin

SYNTHESIS AND FORMULATION STATEMENT
THE INTERNATIONAL CONFERENCE ON INLAND FISHERIES

Palembang, September 2-4, 2014

1. The Agency for Marine Affairs and Fisheries Research and Development through Research Institute for Inland Fisheries has already conducted International Conferences on Inland Capture Fisheries 4 times since 2008. Together with the conferences at national level, there had been 11 conferences on Inland Capture Fisheries since 2004. A couple of recommendations had already been launched through these important conferences. It is expected that the conference could be continued regularly in the coming years.
2. FAO indicated that Inland fisheries are vitally important to South East Asia and to the world in general. In 2012, a record of 11.6 million tons was reported by FAO as harvested from the world's inland fisheries. Asia accounts for 2/3 of all inland capture fishery production. Of the top 15 producing countries, eight are in Asia and five of these are in South East Asia. SEAFDEC Member States contribute more than 2.6 million tons to global production. However, this is thought to be a vast underestimation of the real production from inland capture fisheries in those SEAFDEC countries members.
3. SEAFDEC noted that in 2012, the total production of South-east Asian countries inland fisheries were 2.8 million MT. Myanmar contributed 44 percent of the total production, Cambodia 19 percent, Indonesia 14 percent, Thailand 8 percent, Vietnam and the Philippines 7 percent respectively, while the rest were shared by Lao PDR and Malaysia. The data showed that inland fisheries activities are among the important source of income and protein supply for most of the ASEAN countries.
4. Major characteristics of ASEAN inland fisheries are: involving large number of small-scale fishers (including part-time and subsistent fishers), highly seasonal, highly diversified production (small in size, but large in number, with high species diversity), no designated fishing port, and targeted for household consumption, sold in local/domestic markets, or exported to intra-regional markets. The challenge is then to convert this restriction into opportunity to develop inland fisheries in the near future.
5. The current South East Asia Inland Fisheries issues. In general within each of the South East Asian Country there are challeges and opportunity such as: (i) low Priority by planners & decision on Inland water Fisheries; (ii) application of ecosystem approach to balance the development project and ecosystem function; (iii) mitigation measures to secure the ecosystem function; (iv) maximising utilization of inland fisheries resources; (v) fisheries resources enhancement program; and (vi) adaptation of inland fisheries to climate change.
6. In relation to the inland fisheries production, it is raised three important issues: organic deposition of feces and uneaten feed; ammonia production; and other factors such as

genetics, invasive species, and drugs/chemicals. The issues are mainly related to the fact that only 25-30% of feed fed to fish ends up as harvested fish tissue; the rest ends up in the environment. It is therefore important for inland fisheries activities to consider these three concepts to lead to sustainable inland fisheries activities: ***Production Carrying Capacity***- maximum aquaculture production that does not have unacceptable impacts on the farm itself; ***Ecological Carrying Capacity-***maximum aquaculture production that does not cause unacceptable impacts to the ecosystem; and ***Social Carrying Capacity***-maximum aquaculture production that does not cause unacceptable impacts to the social system.

7. Toward sustainable inland aquaculture is connecting to the competition among stakeholders. Inland aquaculture is affected by many other sectors which might give more economic benefits. Initiating ecosystem approach to fisheries management for example will be beneficial on multi stake holders and different administrative levels. Lesson learnt from one country might be useful for the others through the regional cooperation.
8. Related to the coming ASEAN Economic Community 2015, there will be one market of inland fisheries as well as one production base. In addition, there will be stronger competition among users for limited land and water resources. It is then required for ASEAN Countries to be aware of the characteristics of inland capture fisheries to be linked with other related activities, challenges and opportunity for inland fisheries sustainability, developing cooperation for the sustainability, and deciding regional priority on each of the participating countries. ASEAN and SEAFDEC activities may be of help of these regards.
9. Tropical peatland is considered to be potential in supporting inland fisheries and aquaculture activities. With this regards, Tropical-peatland-based aquaculture has to be spatially arranged with landscape of the surrounding areas. Deep rooted plantation using deep drainage canals will be conflicted as of water management concern with aquaculture. Spatial planning is then considered to be the key factor.
10. Tropical peatland has good potential for aquaculture in rivers, lakes, using ***"beje"*** or normal pool schemes. Fisheries development in peatland will provide another important contribution in reducing carbon emissions due to its process that involve keeping the area wet (rewetting) and as buffers limiting the spread of fire in peat. In addition, naturally contributes to the livelihood and income to communities around peatland areas.
11. ***"Beje"*** is a traditional fishing method in tropical peat and peat forests, to provide a source of food from traditional fisheries, relying on fluctuations in the movement of water or overflow of river water during the rainy season (November to March) by using a trap in the form of an artificial pond or special tools, allowing fish to breed in the pond and later harvested during the dry season when the water recedes (April to October).
12. As a country with the world's largest reserves in tropical peatlands, ***"beje"*** must be an important "science asset" in the strategy to reduce carbon emissions, the "target" is not only "***beje"***, but returning the area to produce fish. Successful implementation of this proposal will

be a great contribution to science to reduce carbon emissions by rewetting method. The science of rewetting in Indonesia will be a source of inspiration for the region, especially in countries that have peat reserves such as Malaysia, Thailand, Vietnam and Papua New Guinea. It will also become a source of scientific data to be studied by universities and world experts on tropical peat.

13. Due to its closeness to the everyday activities of local communities, inland fisheries are frequently characterized by local wisdoms application. In major provinces in Sumatera Island, for example, Lubuk Larangan (forbidden stream pool) is applied consistently. For a certain agreed period, fishing activities are forbidden in that lubuk/stream pool. This is related to the nature of the stream pool as an ideal place for juvenile fish habitat. Specific efforts are needed to preserve this inland fisheries conservation practices.
14. There is a strong indication that women are involved not only in post-harvest activities but are also active in harvesting fish in inland fisheries activities. Women are active in small-scale processing and marketing of fish. Both women and men consider fishing as men's work but women are almost equally involved in fishing activities. Gender division of labor should be seen as dynamic rather than static issues. It is therefore important that women's activities are fully supported so they will be able to continue to contribute in providing inexpensive but high quality protein to the country's poor.
15. Satellite radar facility developed by INDESO Project would be available in the near future. This technology would support in evaluating the actual total area of inland waters potential for capture fisheries and indentifying the potential location of favorable areas for developing freshwater aquaculture to support the industry and readapt the pond management plans.
16. Upwelling research initiatives has been proposed for joint regional cooperation research for 2015-2019. The project would be focused on physical and bio-geo-chemistry process through observation and numerical model, and its impact on human dimension aspects. Inland fisheries research and management, particularly on eels as high-value fish, will be potentially and expected to be involved in human dimension aspects as a linkages between inland and ocean fisheries. It is expected that this could be a milestone toward comprehensive sea-inland management and conservation of eel.
17. Inland waters biodiversity is continuously threatened by overfishing, water pollution, habitat destruction, flow modification, and invasive species. As it is now being global challenge, it is important to include climate change studies along the attempt to minimize, to manage, and adapt those problems. This is likely since the deterioration of both habitat and its natural resources in inland waters are combination effect of both natural and anthropogenic impact.
18. Challenges and opportunity faced by South-east Asian countries are: low priority on inland waters fisheries development among planners; application of ecosystem approach to balance the development project and ecosystem function; mitigation measures to secure the

ecosystem function; optimising utilization of inland fisheries resources; fisheries resources enhancement program; and adaptation of inland fisheries to climate change.

19. Applying Ecosystem Approach to Fisheries Management (EAFM) for inland water fisheries is highly recommended. EAFM is an ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, a-biotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries. The application is then expected to be very valuable in developing inland fisheries without endangering the environment.
20. Important agendas on inland fisheries development on the near future are: improving inland fisheries data including actual inland waters areas and fish catch data; developing data management system internally and among related countries, developing best practices on inland fisheries that underlining conservation and sustainability aspects, identifying and strengthening local wisdom application on inland fisheries activities, developing and supporting the role of women in inland fisheries activities, and developing further awareness on inland fisheries existence at international level.

Formulators Team

Andin Taryoto, Bambang Setiadi, Robiyanto H Susanto, Ngurah N Wiadnyana, A Karim Gaffar, Mukhlis Kamal, and Arif Wibowo

LIST OF CONTENT

ECOLOGY AND STRUCTURE OF MANGROVE ECOSYSTEMS IN MUSI ESTUARINE WATERS AND BANYUASIN ESTUARINE WATERS, SOUTH SUMATRA

Melki & Isnaini[1]

ABSTRACT

Mangroves are plant communities of the intertidal coastal zone in the tropics which are dominated by several species of trees or shrubs characteristic that is influenced by the tide. Mangrove tree species show various physiological and structural adaptations in response to the unfavourable environment - unstable substrate, water-logged anaerobic soil and salty external medium with low osmotic potential because different plant species have different responses to the unfavourable conditions. This study aimed to analyze the ecology and structure of mangrove vegetation in Musi estuarine waters and Banyuasin estuarine waters. The experiment was conducted in June to July 2014. Data was collected using transect method where the size of 10m x 10m for trees sampling, 5m x 5m for saplings and 1m x 1m for seedlings. Parameters for analysing aspects of the mangrove ecology are relative density, relative dominance, relative frequency, importance value of a species and water quality in soil (salinity, pH, temperature and soil) were collected from each site from a rooting depth of 10 cm. Mangroves are found in Musi estuarine waters as many as four species of mangroves, among others S. alba, A. marina, A. alba, and N. fruticans. In Banyuasin estuarine waters as many as five species of mangroves such as A. marina, So. alba, B. gymnorrhiza, R. mucronata and N. fruticans. The results showed that A.marina has the highest number of species and the highest importance value index of 300. The average water quality in soil mangroves were found 28-32 ^{o}C for temperature, pH 4.8-6.4 and salinity 0-28 ppt.

Keywords: *Mangrove structure, soil quality, Musi estuarine waters and Banyuasin estuarine waters*

INTRODUCTION

The mangrove environment has some special physicochemical characteristics of salinity, tidal currents, winds, high temperatures,and muddy anaerobic soil. Plants are able to adapt to themselves to practically all types of adverse conditions except perhaps frost, and hence they are distributed mostly in the tropical regions. Probably there are no other groups of plants with such highly developed adaptations to extreme conditions. Mangroves occur in lowlying, broad coastal plains where the topographic gradients are small and the tidal amplitude large (uncommon, rewrite). Repeatedly getting flooded, but welldrained soil supports a rich growth of mangrove plants. They normally grow poorly in stagnant waters and have luxuriant growth in the alluvial soil substrates with fine-textured loose mud or silt, rich in humus and sulphides. They can also be found in substrates other than muddy soil such as coastal reefs and oceanic islands. In such areas, the mangrove plants grow on peat, which is derived from decayed vegetation. They find it difficult to colonize the coastal zone with waves of high energy and hence they normally establish themselves in sheltered shorelines (Kathiresan & Bingham, 2001).

Waring & Major (1964) reported that a complex of environmental factors determines the actual distribution of plants in nature, although each plant has a certain tolerance for each factor. Since the mangrove habitat is basically saline, several studies have attempted to correlate salinity with the standing crop of vegetation and productivity (Chen & Twilley, 1999; Ukpong 1991). Local patterns of tidal inundation further influence soil characteristics that control species zonation of mangrove wetlands (Banerjee 1987; Naidoo 1980; Saha & Choudhury 1995).

[1]*Marine Science Departement, Sriwijaya University*

The objectives of the research are to analyze ecology and structure of mangrove ecosystems in Musi Estuarine Waters and Banyuasin Estuarine Waters, province of South Sumatra. It is expected that the outputs could be used for area description (?, rewrite), better strategies and approaches, in order to mitigate the existing problem concerning mangrove forests, especially in the South Sumatra area.

MATERIALS & METHODS

The research was conducted in June to July 2014 in the area of Musi Estuarine Waters and Banyuasin Estuarine Waters (Fig. 1). There are seven sites (Musi Estuarine Waters such as site I, II, III and IV. Banyuasin Estuarine Waters such as site V, VI and VII) which interest in this area (?, rewrite)was collected using transect method where the size of 10m x 10m for trees, 5m x 5m for saplings and 1m x 1m for seedlings. Data to be collected and processed in the following process:

- Basal area is measured species wise (?) and total in each plot as follows:

Basal area (m^2) of each species = 0.005 x DBH

Total basal area of all species (m^2/ha) = sum of all species basal area / area of plot in m^2 x 10,000 m^2

- Relative density = no. of individuals of a species / total no. of individuals of all species x100
- Relative dominance = total basal area of a species / basal area of all species x 100
- Relative frequency = frequency of species/ total frequency of all species in different plots x 100
- Importance value of a species = relative density + relative dominance + relative Frequency

And also the parameters for analysing water quality in soil are salinity, pH, temperature and soil charateristic were collected from each site from a rooting depth of 10 cm.

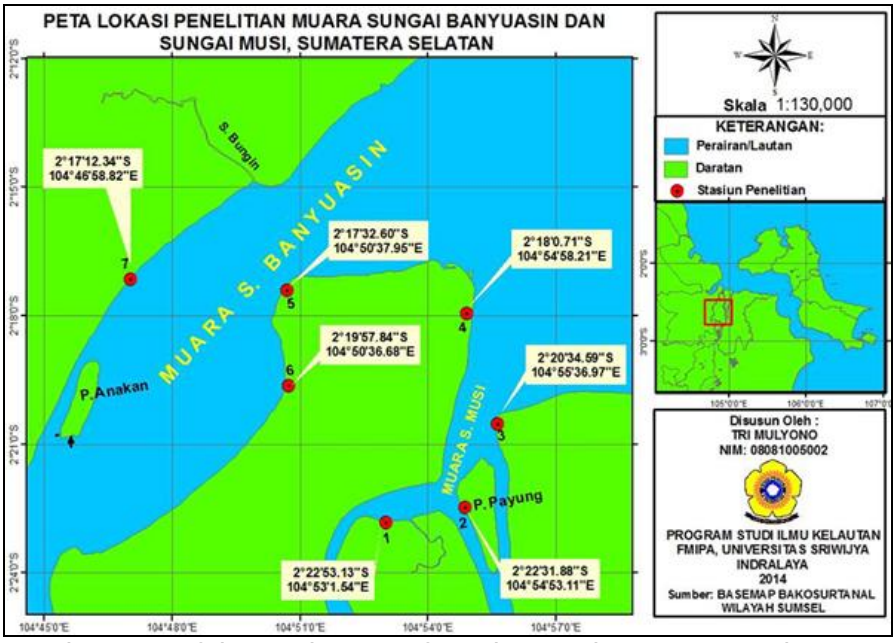

Figure 1. Location map of the study area of Musi Estuarine Waters and Banyuasin Estuarine Waters, South Sumatra.

RESULTS AND DISCUSSION

Structure of Mangrove Ecosystems

A total of seven species were found in seven sites (Table 1). Mangroves are found in Musi estuarine waters as many as four species of mangrove, among others *S. alba, A. marina, A. alba,* and *N. fruticans.* In Banyuasin estuarine waters as many as

five species of mangrove such as *A. marina, S. alba, B. gymnorrhiza, R. mucronata* and *N. Fruticans (*rewrite).

Table 1. Structural characteristics of the species recorded at Musi Estuarine Waters and Banyuasin Estuarine Waters

Sites	Mangrove category	Species	ni	Relative density	Relative dominace	Relative frequency	Importance Value
I	Tree	Aa	11	100	100	100	300
		Nf	4				
	Seedling	Aa	11	100	100		200
II	Tree	Am	15	88.24	66.67	28.22	183.12
		Aa	2	11.76	33.33	71.78	116.88
		Nf	1				
	Sapling	Am	3	100	100	100	300
	Seedling	Am	1	33.33	33.33		66.66
		Aa	2	66.67	66.67		133.33
III	Tree	Am	12	100	100	100	300
		Nf	37				
	Seedling	Am	34	89.47	50		
		Aa	4	10.53	50		
IV	Tree	Am	12	70.59	60	0.07	130.66
		Sa	5	29.41	40	99.93	169.34
V	Tree	Am	46	100	100	100	300
	Sapling	Am	7	100	100	100	300
VI	Tree	Sa	13	56.52	42.86	13.9	113.28
		Bg	7	30.43	42.86	41.71	115
		Rm	3	13.04	14.29	44.39	71.72
		Nf	2				
	Sapling	Sa	1	100	100	100	100
	Seedling	Rm	1	11.11	20		
		Bg	3	33.33	20		
		Sc	5	55.56	60		
VII	Tree	Am	13	86.67	75	93.96	255.62
		Kc	2	13.33	25	6.04	44.38
	Sapling	Kc	2	100	100	100	300
	Seedling	Am	3	100	100		

Aa *(Avicennia alba),* Am *(Avicennia marina),* Bg *(Bruguiera gymnorrhiza),* Kc *(Kandelia candel),* Nf *(Nypa fruticans),* Rm *(Rhizophora mucronata),* Sa *(Sonneratia alba)*

The species that the highest number of species (rewrite) in Musi Estuarine Waters are *N. fruticans* and *A. marina.* The species of *A. marina* that the highest species in Banyuasin Estuarine Waters.

Table 1 indicates that the forest is largely composed of large sized trees. *A. marina* occupied the maximum relative dominance (100), the maximum relative density (100) and the maximum relative frequency (100) at the sites I, III and V. *K. candel* the minimum relative dominance (25), the minimum relative density (13.33) and the minimum relative frequency (6.04) at the sites VII. Among tree species *A. marina* got the highest importance value (130-300)

followed by *A. alba* (116) and *B. gymnorrhiza* (115).

The mangroves in Musi Estuarine Waters and Banyuasin Estuarine Waters is largely dominated by *A. Marina*, pointing to its wide adaptability in different environments. From the present observations, it is revealed that most of the species occupy a zone to which it is best adapted, however, there are overlapping occurrences of different species although with varying ecological optima along salinity and pH gradients. The mangroves obviously share a niche attribute for these two factors in soil.

Water Quality in Soils

The soil temperature ranged from 28 ^{o}C at site VII of mangrove *A. marina* to 32 ^{o}C at site III of mangrove *N. fruticans*. The average soil pH from 4.8 at site I of mangrove *A. alba* to 6.4 at site VI of mangrove *A. marina*. The soil salinity ranged from 0 ppt at site II of mangrove *A. marina, A. alba* and *N. fruticans* to 28 ppt at site VII of mangrove *A. marina.* There are differents soil charateristics of mangroves soil in Musi Estuarine Waters and Banyuasin Estuarine Waters from mud to sandy mud (Table 2).

Mangrove species in Musi Estuarine Waters and Banyuasin Estuarine Waters are found in wide ranges of soil temperature, pH and salinity. They are restricted to soils having low salinity. It seems that most mangrove species have an optimum pH range like terrestrial plants, but they can tolerate lower salinity. *A. marina* occurred in varied salinity conditions from 0 ppt to 28 ppt. The complexity of vegetation increased with decrease in soil salinity. Kathiresan *et al.* (1996) generally mangrove vegetation is more luxuriant in soils with lower salinities.

Table 2. Specific ecology of mangrove soil in Musi Estuarine Waters and Banyuasin Estuarine Waters

Sites	Mangroves	Temperature (^{o}C)	pH	Salinity (ppt)	Soil Charateristic
I	Aa	30	4.8	5	Mud
	Nf	30	5.6	5	Mud
II	Am	29	5.6	0	Mud
	Aa	28	5.6	0	Mud
	Nf	28	5.7	0	Mud
III	Am	29	5.3	3	Mud
	Nf	32	5.4	2	Mud
IV	Am	29	6.2	3	Sandy mud
	Sa	29	6.2	3	Sandy mud
V	Am	29	6.2	3	Mud
VI	Bg	29	6.2	5	Sandy mud
	Sa	29	6.1	5	Mud
	Rm	29	6.1	5	Sandy mud
	Am	29	6.4	5	Mud
VII	Am	28	5.3	28	Mud

Aa *(Avicennia alba),* Am *(Avicennia marina),* Bg *(Bruguiera gymnorrhiza),* Kc *(Kandelia candel),* Nf *(Nypa fruticans),* Rm *(Rhizophora mucronata),* Sa *(Sonneratia alba)*

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