



UNIVERSITI PUTRA MALAYSIA

***COMMUNITY AWARENESS OF ECOLOGICAL BENEFITS OF
MANGROVE FOREST IN SIBUTI, SARAWAK, MALAYSIA***

KALEEM SHAH

FSPM 2015 7



**COMMUNITY AWARENESS OF ECOLOGICAL BENEFITS OF
MANGROVE FOREST IN SIBUTI, SARAWAK, MALAYSIA**

By

KALEEM SHAH

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

May 2015

COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

COMMUNITY AWARENESS OF ECOLOGICAL BENEFITS OF MANGROVE FOREST IN SIBUTI, SARAWAK, MALAYSIA

By

KALEEM SHAH

May 2015

Chairman: Abu Hena Mustafa Kamal, PhD
Faculty: Agriculture and Food Sciences (Bintulu)

Mangrove forest is highly productive and plays an important role to the coastal ecosystem functions including livelihoods of the adjacent coastal communities. Like other ecosystems, mangrove provides enormous tangible and intangible benefits to both the local communities and ecology. Millions of people are dependent on mangroves for their livelihoods around the world including Malaysia. Malaysia is gifted with numerous natural resources and nearly 580,000 ha of mangrove forests grow scattered countrywide, whereas, the state of Sarawak contributes 26% to the total. Many researchers in Malaysia have been focused on ecological and environmental aspects of mangroves; however very few research work are documented on social linkage aspect to this unique characteristic of forest particularly in Sarawak. Hence, this study was focused on the mangroves and its benefits to the local community and their awareness level with regard to the mangrove forest of Sibuti, Sarawak. Ethno-ecological approach was adopted during the study. For social aspect, data was recorded from 60 respondents using simple random sampling techniques in three villages surrounding Sibuti mangrove forest through structured and semi-structured interview schedule. While, field survey was conducted through transect line method for species composition and diversity of mangroves in three transects randomly by establishing (10 ×10 m) plots perpendicular from shoreline to inland.

At this current stage, the coastal community was not depended on Sibuti mangroves forest in terms of direct benefits, like; energy fuel wood 52 (87%), timber 58 (97%), grasses/fodder leaves 53 (88%), construction pole/material 58 (97%), livestock grazing 48 (80%), wildlife hunting 43 (72%), Medicinal Plants/NWFPs 55 (92%) and thatching material 57 (95%). However, low dependency was recorded on mangrove forest in term of crabs and mollusk collection 33 (55%), *Nypa* fruits collection 21 (35%) and *Nypa* leaves collection 19 (32%). Fishing was the only direct benefit, which was highly getting by the community 29 (48%) from Sibuti mangrove forest. The community believed that mangrove forest provide them in-direct benefits such as breeding ground of fish 43 (72%), protecting their land from soil erosion 36 (60%), contributing towards land formation 44 (73%), filtering the water resource 39 (65%), increasing scenic view 43 (72%), providing food to the fish 48 (80%), working as nutrients hub for fishes 45

(75%), wildlife habitat 43 (72%), protection from floods 41 (68%), protection from cyclones/storms/tornados 45 (75%) and protecting them from Tsunami 34 (57%). Interest of paying visit to the forest was casually found in 27 (45%). Majority i.e., 36 (60%) viewed Sibuti mangroves as benefited in terms of eco-tourism. Most of the people i.e., 46 (77%) were always willing to play role in the development of Sibuti mangroves, 40 (67%) interested in learning about conservation and protection practices, while 37 (62%) were ready for volunteer role in conservation and protection if assign to them. Most of them i.e., 36 (60%) were ready play role as volunteer and 46 (77%) was ready to work as facilitator. Majority 32 (53%) were willing to pay donations. The educational, research and training program were welcomed by 58 (98%) of the respondents. The people believed that forestry resource could be managed through community involvement. Similar observation was found for fishery, wildlife and eco-tourism development. Joint forest management approach was supported by 47 (78%) and 35 (58%) were satisfied about government efforts for protection, development and conservation of the forest. Majority i.e., 44 (73%) of the people viewed that Sibuti mangrove forest was not facing human pressure on the resource.

Survey on mangrove species composition found that nine true mangroves species were recorded and *Rhizophora apiculata* was recorded as dominated species. The stand density was recorded as 1938 trees ha⁻¹, 1722 saplings ha⁻¹ and 6222 seedlings ha⁻¹. The average diameter of tree in the stand was 21 cm, 13 m for height and 202 m² ha⁻¹ for basal area. The average diameter of dominant species (*R. apiculata*) was 24 cm, height 15 m and basal area 176 m² ha⁻¹. The Importance Value Index (IVI) of *R. apiculata* was 202 followed by 64 for *Xylocarpus granatum*. Shannon diversity indices (H'), Margalef richness (D) and Peilou evenness (J') were calculated to be 1.18, 1.41 and 0.54, respectively. Similarity of species diversity showed two major clusters for the whole forest stand.

The findings of this study suggest that Sibuti mangrove forest was undisturbed and healthy. The people were mostly benefited from indirect uses rather than direct uses and they were well aware of the mangrove forest resources. The forest could be managed and conserved in a better way for multi-sectoral uses like eco-tourism, biodiversity, research and education and community people should be considered as primary stakeholder. Integrated resource management approach should be adopted rather than managing the resource as a wildlife sanctuary only.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

KESEDARAN MASYARAKAT TENTANG MANFAAT EKOLOGI HUTAN PAYA BAKAU DI SIBUTI, SARAWAK, MALAYSIA

Oleh

KALEEM SHAH

Mei 2015

Pengerusi: Abu Hena Mustafa Kamal, PhD
Fakulti: Sains Pertanian dan Makanan (Bintulu)

Hutan paya bakau adalah sangat produktif dan memainkan peranan penting kepada fungsi ekosistem pantai termasuklah menjadi punca pencarian kepada penduduk berdekatan pantai. Seperti ekosistem yang lain, paya bakau menyediakan kebaikan yang sangat ketara dan tidak ketara kepada ekologi masyarakat setempat. Berjuta manusia bergantung kepada hutan paya bakau sebagai sumber pendapatan di seluruh dunia termasuklah Malaysia. Malaysia dianugerahkan dengan kepelbagaian sumber semulajadi dan hampir 580,000 ha hutan paya bakau tumbuh bertaburan di seluruh negara, manakala, negeri Sarawak menyumbang 26% daripada jumlah keseluruhan. Ramai penyelidik di Malaysia mula memberi tumpuan kepada aspek ekologi dan aspek persekitaran paya bakau; walaubagaimanapun hanya sedikit kajian yang di dokumentasikan dari aspek hubungan sosial terhadap ciri-ciri keunikan hutan terutamanya di Sarawak. Justeru, kajian ini menfokuskan kepada paya bakau dan kelebihannya kepada penduduk tempatan dan kefahaman penduduk terhadap hutan paya bakau di Sibuti, Sarawak. Pendekatan etno-ekologikal telah diadaptasi semasa kajian. Untuk aspek sosial, data telah direkodkan daripada 60 responden menggunakan teknik pensampelan mudah secara rawak di tiga buah kampung di sekeliling hutan bakau Sibuti melalui temubual berstruktur dan tidak berstruktur. Manakala, survei lapangan telah dilaksanakan melalui kaedah garisan transek untuk komposisi spesis dan kepelbagaian bakau menggunakan tiga transek secara rawak dengan membuat (10 x 10 m) plot secara lurus ke dalam daripada pantai ke kawasan daratan.

Pada peringkat ini, penduduk pantai tidak bergantung kepada hutan paya bakau Sibuti dari segi manfaat secara langsung, seperti; tenaga kayu bakar 52 (87%), balak 58 (97%), rumput/daun foder 53 (88%), tiang/bahan binaan 58 (97%), padang ragut untuk ternakan 48 (80%), pemburuan hidupan liar 43 (72%), tumbuhan/NWFPS perubatan 55 (92) dan jerami 57 (95%). Walaubagaimanapun, kadar kebergantungan yang rendah telah direkod di hutan paya bakau dari segi pengumpulan ketam dan moluska 33 (55%), pengumpulan buah nipah 21 (35%) dan pengumpulan daun nipah 19 (32%). Perikanan merupakan satu-satunya manfaat secara langsung, yang paling tinggi diperolehi oleh penduduk 29 (48%) dari hutan paya bakau Sibuti. Penduduk tempatan percaya bahawa hutan paya bakau memberi manfaat secara tidak langsung kepada kawasan pembiakan ikan 43 (72%), melindungi kawasan mereka daripada hakisan

tanah 36 (60%), menyumbang kearah pembentukan tanah 44 (73%), menapis sumber air 39 (65%), menambahkan kawasan pemandangan yang cantik 43 (72%), menyediakan makanan untuk ikan 48 (80%), berkerja sebagai nutrient hab 45 (75%), habitat hidupan liar 43 (72%), perlindungan daripada banjir 41 (68%), perlindungan daripada taufan/ribut/putting beliung 45 (75%) dan melindungi mereka daripada tsunami 34 (57%). Minat untuk datang melawat hutan ini secara santai adalah dalam 27 (45%). Majoriti 36 (60%) melihat keuntungan di paya bakau Sibuti adalah melalui eko-pelancongan. Kebanyakan manusia i.e., 46 (77%) sentiasa bersedia untuk memainkan peranan dalam pembangunan paya bakau Sibuti, 40 (67%) berminat untuk belajar mengenai amalan pemuliharaan dan perlindungan, sementara 37 (62%) telah bersedia untuk memainkan peranan sukarelawan dalam pemuliharaan dan perlindungan jika hak diserahkan kepada mereka. Kebanyakan mereka i.e, 36 (60%) bersedia memainkan peranan sebagai sukarelawan dan 46 (77%) bersedia bekerja sebagai fasilitator. Majoriti 32 (53%) sanggup membayar derma. Program pembelajaran, kajian dan latihan disambut oleh 58 (98%) daripada responden. Penduduk percaya sumber hutan boleh diurus melalui penglibatan komuniti. Pemerhatian yang sama dilihat untuk kemajuan perikanan, hidupan liar dan eko-pelancongan. Pendekatan pengurusan hutan bersama disokong oleh 47 (78%) dan 35 (58%) berpuas hati dengan usaha kerajaan untuk melindungi, membangun dan memulihara kawasan hutan ini. Majoriti i.e 44 (73%) penduduk melihat hutan paya bakau Sibuti tidak menghadapi tekanan manusia terhadap sumber.

Survei ke atas komposisi spesis bakau telah merekodkan Sembilan spesis bakau sebenar dan *Rhizophora apiculata* merupakan spesis yang mendominasi. Kepadatan pokok direkodkan sebagai 1938 pokok ha⁻¹, 1722 anak pokok ha⁻¹ dan 6222 anak benih ha⁻¹. Purata diameter diri adalah 21 cm, 13 m untuk tinggi dan 202 m² ha⁻¹ untuk pangkal. Purata diameter spesis dominan (*Rhizophora apiculata*) adalah 24 cm, tinggi 15 m dan kawasan pangkal 176 m² ha⁻¹. Indek Nilai Penting (IVI) untuk *Rhizophora apiculata* adalah 202 diikuti dengan 64 untuk *Xylocarpus granatum*, Index Kepelbagaian Shannon (H'), Kekayaan Margalef (D) dan Kesamaan Peilou (J) telah dikira sebagai 1.18, 1.41 dan 0.54 masing-masing. Kesamaan kepelbagaian spesis menunjukkan dua kluster utama untuk keseluruhan dirian hutan.

Hasil dari kajian ini menunjukkan bahawa hutan paya bakau Sibuti tidak terganggu dan sihat. Penduduk mendapat manfaat daripada sumber tidak langsung berbanding sumber langsung dan mereka sedar akan kepentingan sumber hutan paya bakau. Hutan ini dapat diurus dan dipelihara dengan cara yang lebih baik untuk pelbagai sektor seperti eko-pelancongan, biodiversiti, penyelidikan dan pembelajaran dan penduduk seharusnya dianggap sebagai pemegang utama. Pendekatan pengurusan sumber bersepadu perlu digunapakai bukan semata-mata menguruskan sumber sebagai santuari hidupan liar sahaja.

ACKNOWLEDGEMENTS

In the name Allah almighty, the most merciful and the most beneficial. All praise to Allah, whom give me the strength and ability to come for studies abroad and complete it at this stage of my life.

I, highly acknowledge my supervisory committee, the Chairman (Dr. Abu Hena Mustafa Kamal), members (Dr. Adrian Daud and Dr. Zamri bin Rosli) Faculty of Agriculture and Food Sciences, UPM Bintulu, Sawarak. Without their full professional guidance and strong support, it was not possible for me to complete this task. They gave me their valuable time (when and where) I needed during my study period.

Thanks to my parent Department (Environment Department, Govt. of Khyber Pakhtunkhwa, Pakistan), which allow me to enhance my academic qualification. Special thanks to Muhammad Younus Khan (Ex-Chief Conservator of Forest, Govt. of Khyber Pakhtunkhwa, Pakistan), who encouraged and supported me in this regard. Undoubted thanks to my office colleagues, friends and family members, who helped me in my absence for my personal matters.

I would also like to thanks all my fellows, colleagues and friends in the Faculty, whom supported me and helped me in each sphere of my work. Special thanks to Muhammad Muzammel Hoque, A.S.M. Saifullah, Muhammad Masum Billah, Maru Ali and Muhammad Rozaidi bin Muhammad Yousaf for their valuable discussions and precious inputs.

Special thanks to Sarawak Biodiversity Centre (SBC) and Sarawak Forestry Department for their cooperation and permission to conduct my research work at Sibuti Mangrove Forests, Miri, Sarawak. I am also grateful to KPT for financial support from project No. K-EDU/100(UPM-12) for my field survey data collection.

I wish to acknowledge and pay thanks to the academic and non academic staff of UPMKB, whom helped me and extended their support during my course of study. Special thanks to Muhammad Fauzi, for his optimum help during my study period.

I certify that a thesis examination committee has met on 13/05/2015 to conduct the final examination of Mr. Kaleem Shah on his thesis titled “Social Linkages and ecological attributes of mangrove forests: A study of Sibuti, Sarawak” in accordance with the Universities and University College act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 march 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohd Hanafi bin Idris, PhD

Senior Lecturer

*Faculty of Agriculture and Food Sciences,
UPMKB, Universiti Putra Malaysia
(Chairman)*

Seca Gandaseca, PhD

Associate Professor

*Faculty of Forestry,
Universiti Putra Malaysia
(Internal Examiner)*

Tapan Kumar Nath, PhD

Associate Professor,

*Faculty of Science,
The University of Nottingham, Malaysia
(External Examiner)*

***ZULKARNAIN ZAINAL, PhD
PROFESSOR AND DEPUTY
DEAN***

*School of Graduate Studies
Universiti Putra Malaysia*

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the Degree of Master of Science. The members of the Supervisory Committee were as follows:

Abu Hena Mustafa Kamal, PhD

Senior Lecturer
Faculty of Agriculture and Food Sciences
Universiti Putra Malaysia Bintulu Sarawak Campus
(Chairman)

Adrian Daud, PhD

Senior Lecturer
Faculty of Agriculture and Food Sciences
Universiti Putra Malaysia Bintulu Sarawak Campus
(Member)

Zamri Bin Rosli, PhD

Senior Lecturer
Faculty of Agriculture and Food Sciences
Universiti Putra Malaysia Bintulu Sarawak Campus
(Member)

BUJANG KIM HUAT, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 9 July 2015

Declaration by Graduate Student

I hereby confirm that:

- This thesis is my original work;
- Quotations, illustrations and citations have been duly referenced;
- This thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- Intellectual property from the thesis and copyright of thesis are fully-owned; by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- Written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- There is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature.....

Date 22 July 2015

Name and Matric No Kaleem Shah (GS 38452)

TABLE OF CONTENTS

		Page
ABSTRACT		i
ABSTRAK		iii
ACKNOWLEDGEMENTS		v
APPROVAL		vi
DECLARATION		vii
LIST OF TABLES		xiii
LIST OF FIGURES		xiv
LIST OF ABBREVIATIONS		xv
 CHAPTER		 1
1	INTRODUCTION	1
	1.1 Background	1
	1.2 Problem Statement	2
	1.3 Significance of Study	3
	1.4 Objectives	3
 2	 LITERATURE REVIEW	 4
	2.1 Definition of Mangroves	4
	2.2 Distribution, Habitat and Types of Mangroves	4
	2.3 Status of Mangrove in Sarawak, Malaysia	6
	2.4 Direct Benefits of Mangroves Forests	7
	2.4.1 Timber, Fuel Wood, Charcoal, Construction Materials and other Uses	7
	2.4.2 Hub for Aquaculture and Fishing	7
	2.4.3 Area for Animal Grazing	8
	2.4.4 Sites for Eco-tourism, Research and Education	8
	2.4.5 Apiculture Production Areas	9
	2.4.6 Medicinal Plants and Non-wood Forest Products (NWFP)	9
	2.5 Indirect Benefits and Services of Mangroves Forests	9
	2.5.1 Tsunami Controlling Compound	9
	2.5.2 Flood Protecting Compound	10
	2.5.3 Controlling Land Erosion and Land Stabilization	10
	2.5.4 Food and Nutrients Hub	10
	2.5.5 Wildlife Habitat	11
	2.5.6 Contributing to Mitigate Green House Gases and Carbon Sequestration	11
	2.6 Threats to Mangrove Ecosystems	12
	2.7 Community Awareness	13
	2.7.1 Definition of Awareness in Forestry Context	13
	2.7.2 Community Awareness and Sustainable Mangrove Forest Management	14
	2.7.3 Importance of Community Awareness in Mangrove Forest Management	14
	2.7.4 Parameters of Community Awareness	14

3	ASSESSMENT OF TANGIBLE AND INTANGIBLE BENEFITS OF SIBUTI MANGROVE FOREST	15
3.1	Introduction	15
3.2	Materials and Methods	16
3.2.1	Location of the Study Area	16
3.2.2	Data Collection	16
3.2.3	Data Analysis	17
3.3	Results	18
3.3.1	Community Profile	18
3.3.1.1	Basic Information and Facilities of the Villages	18
3.3.1.2	Education, Gender and Age Group of the Respondents	18
3.3.1.3	House Structure of the Respondents	18
3.3.1.4	Monthly Income of the Respondents	19
3.3.1.5	Source of Income of the Respondents	19
3.3.1.6	Trend of Energy Resource Used for Cooking	20
3.3.2	Direct and In-direct Benefits of Sibuti Mangroves Forest	20
3.3.2.1	Direct Benefits of the Mangrove Forest	20
3.3.2.2	In-direct Benefits and Services Mangrove Forest	22
3.3.2.3	In-direct Benefit (Eco-tourism)	22
3.3.3	Community Awareness Level about Sibuti Mangrove Forest	23
3.3.3.1	Visiting of People to the Mangrove Forest	23
3.3.3.2	Willingness of People to Participate in Various Activities	23
3.3.3.3	Participation Regarding Awareness Raising Events/Functions	24
3.3.3.4	Community Involvement in Different Activities at Sibuti Mangrove Forest Resource Management	25
3.3.3.5	Community Understanding about Existing Role of Government	26
3.3.3.6	Community Understanding about Mangrove Forest Management	26
3.3.4	Human Incurred Threats to the Sibuti Mangrove Forest	27
3.3.5	Community Understanding About Forest Depletion	27
3.3.6	SWOT Analysis	28
3.4	Discussion	30
3.5	Conclusion	34
4	COMPOSITION AND DIVERSITY OF PLANT IN SIBUTI MANGROVE FOREST, SARAWAK, MALAYSIA	35
4.1	Introduction	35
4.2	Materials and Methods	36
4.2.1	Location and Basic Information of the Study Area	36
4.2.2	Data Collection	36
4.2.3	Data Analysis	36
4.3	Results	38
4.3.1	Species Compositions of Sibuti Mangroves Forest	38

4.3.2	Density, Diameter, Height and Basal Area of the Stand	38
4.3.3	Diversity, Richness and Evenness for Species Composition	39
4.3.4	Importance Value Index of Species (IVI)	39
4.3.5	Tree Abundance, Diameter Class and Stand Clustering	41
4.4	Discussion	43
4.5	Conclusion	44
5	SUMMARY, CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH	45
5.1	Summary and Conclusion	45
5.2	Recommendations for Future Research	46
	REFERENCES	48
	APPENDICES	58
	BIODATA OF STUDENT PUBLICATION	70
		71

LIST OF TABLES

Table		Page
2.1	Direct benefits of mangrove forest adopted from FAO, (1994).	8
2.2	Cash benefits of mangroves forests.	9
3.1	Educational level, gender and age group of the respondents in study area.	18
3.2	Source of income and profession of the respondents in the study area.	19
3.3	Summary of direct benefits taking by the coastal community from Sibuti mangrove forest.	21
3.4	Summary of indirect benefits and services of Sibuti mangrove forest.	21
3.5	Community response for eco-tourism benefits in Sibuti mangrove forest.	23
3.6	Community willingness to participate in various roles.	24
3.7	Awareness raising events/functions regarding Sibuti mangroves.	25
3.8	Response regarding activities through community involvement in Sibuti mangrove forest.	25
3.9	Community understanding about forest depletion in study area.	28
3.10	SWOT analysis of Sibuti mangrove forest resource.	29
4.1	List of plant species recorded in Sibuti mangroves forest.	39
4.2	Tree, sapling and seedling density (no. ha ⁻¹), diameter (cm), basal area (m ² ha ⁻¹) and height (m) with respect to transects in Sibuti mangrove forest.	40
4.3	Diameter (cm), basal area (m ² ha ⁻¹), height (m), no. of trees (ha ⁻¹) and frequency of mangroves species in Sibuti mangrove forest.	40
4.4	Relative dominance (%), relative density (%), relative frequency (%) and Importance Value Index (IVI) of mangroves in Sibuti mangrove forest.	40

LIST OF FIGURES

Figure		Page
2.1	Worldwide Distribution of Mangroves Forests (FAO, 2007).	5
2.2	Percentage of Mangroves Worldwide by Country (FAO, 2007).	6
2.3	Percentage of Mangroves in Asian Counties (Giri <i>et al.</i> , 2011).	6
2.4	Economic and Ecological Benefits and Services of Mangroves (Adopted from Berjak <i>et al.</i> , 1977).	11
2.5	Changing Trends of Mangroves Area in Asian Countries (FAO, 2007).	13
3.1	Respondents' House Structure in the Study Area.	18
3.2	Monthly Income of the Respondents in the Study Area.	19
3.3	Use of Energy Resource for Cooking in the Study Area.	20
3.4	People Benefited from Eco-Tourism in the Study Area.	22
3.5	Frequency of Visiting by Community People to Sibuti Mangrove Forest.	23
3.6	Community Response Regarding Existing Role of the Govt. in Sibuti Mangrove Forest.	26
3.7	Community Response for Proposed Management of Sibuti Mangrove Forest.	26
3.8	Threats to Sibuti Mangrove Forest.	27
3.9	Community Response about Forest Depletion.	27
4.1	Location of the Sibuti Mangrove Forests Showing the Positioning of the Transects (T1, T2, T3) and Plots (1-13).	37
4.2	Forest Structure of Sibuti Mangrove (A: <i>Nypa fruticans</i> ; B&G: <i>Rhizophora apiculata</i> , C: <i>Intsia bijuga</i> ; D: <i>Xylocarpus mekongensis</i> ; E: <i>Xylocarpus granatum</i> ; F: <i>Excoecaria agallocha</i> ; H: <i>Thespesia populnea</i> ; I: <i>Phoenix paludosa</i> ; J: <i>Acrostichum speciosum</i>).	38
4.3	Diversity (H'), Richness (D) and Evenness (J') Index for Species Composition of Sibuti Mangrove Forest in different transects (T-1 to T-3).	41
4.4	Tree Abundance and Number of Species Recorded in Different Plots (P-1 to P-13) of Sibuti Mangrove Forests.	41
4.5	Number of Trees by Diameter Class (DBH) in Sibuti Mangrove Forest.	42
4.6	Dendrogram of Species Clustering and Similarity.	42

LIST OF ABBREVIATIONS

°C	Centigrade
CAP	Community Analysis Packages
cm	Centimeter
D	Margalef richness
DBH	Diameter at Breast Height
FAO	Food and Agriculture Organization
Govt.	Government
H'	Shannon diversity
Ha	Hectare
IFRC	International Federation of Red Cross
ILO	International Labor Organization
IUCN	International Union for Conservation of Nature
IVI	Important Value Index
J'	Peilou evenness
Kg	kilogram
Km	kilometer
m	Meter
NWFP	Non Wood Forest Products
RM	Ringgit Malaysia
SDR	Species Diversity Richness
SWOT	Strengths, Weakness, Opportunities and Threats
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UPM	Universiti Putra Malaysia
UPMKB	Universiti Putra Malaysia Kampus Bintulu
US\$	United States Dollar
UV	Ultra Volute
WTP	Willing To Pay

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

Mangroves are coastal plants, which mostly grow in the intertidal area of tropical and subtropical shorelines, and resistance to high salt concentrations (Saenger, 2002). These plants are mainly divided into three major categories i.e., true-mangroves, mangroves and mangroves-associates (Wan Juliana *et al.*, 2010). There are 15.2 million hectares of mangroves forests around the world (FAO, 2007). These forests are distributed in almost 123 countries, covering an area of about 1% of the world surface. Asia consists 37% of mangrove forests, while 27.2% in North and South America followed by 21% in Africa and 12.4% in Australia (FAO, 2007; Sandilyan and Kathiresan, 2012). In Malaysia, 0.580 million ha mangroves forests are distributed along the coastal and estuarine areas, in which, 60% is covered by Sabah, 26% by Sarawak and 13% by Peninsular (Shukor, 2004; Latif and Faridah-Hanum, 2014).

Mangroves forests are highly productive and play an important role to the coastal ecosystem functions including livelihoods of the adjacent coastal communities (Kathiresan and Bingham, 2001). Since very long time, people used mangroves forests for timber and commercially exploited these forests for durable construction poles, tannin, firewood and charcoal (FAO, 2007; Spalding *et al.*, 2010). The wood are used in boat building, housing, heavy construction, papers and chipboards business industries in the same manner as the terrestrial forests (Clough, 2013). Mangrove species like *Nypa* are used for thatching material, cigarette wrappers mats and baskets, hats, bags mats, wrappers, raincoats and juice tapped for conversion into alcohol (FAO, 2002; Shukor, 2004; Kathiresan, 2012). In Asia, millions of people are dependent on mangroves forests e.g. Sundarbans mangroves forests of Bangladesh and India support around 9 million people for their day-to-day life (Viswanathan *et al.*, 2011). These forests provide more than 70 direct human activities and services, which vary from forestry to fisheries resources (Dixon, 1989; Lucy, 2006). Mangroves are also very common vicinity for grazing of animals (Qasim, 1998) and can also provide high opportunities for eco-tourism (Kathiresan and Bingham, 2001). Apiculture activities are also attractive business in the mangroves forest area. The study of Krishnamurthy (1990) has calculated that apiculture sector provided employment to 2000 persons and annually produced 111 tons of honey in Sundarbans mangroves forests. FAO (2007) has reported mangroves forests as a potential source of medicinal plants and Non Wood Forest Products (NWFP).

Mangrove forests have the buffering capacity to stop storms (Garcia *et al.*, 2014) and protect the coastline from flood usually happened due to heavy rainfall (Kathiresan, 2012). Mangroves systems are like buttress system, where the strong roots of plants make natural buffer between the land and the sea. These also have the capacity to break wave action and strong winds (Latif and Faridah-Hanum, 2014). This ecosystem also helps in recycling of nitrogen, carbon and sulphur (Kathiresan, 2012). Mangroves ecosystems provide habitats, spawning grounds to many animals and support rich biological diversity (Faridah-Hanum *et al.*, 2012). The diverse vegetation composition, structure and dense foliage of mangroves have created different layers of heterogeneous habitats, which support variety of wildlife and marine organisms

(Garcia *et al.*, 2014; Rajpar and Zakaria, 2014b). These wildlife communities utilize mangroves forests for foraging, breeding and loafing and helping to make the nature in balance (Spalding *et al.*, 2010; Rajpar and Zakaria, 2014b).

1.2 Problem Statement

In spite of high amount of benefits and services of this important coastal ecosystem, mangrove forests are depleted at average rate of 0.66% per year globally and 15 million ha are lost in 1990s' and mostly happened in tropics (FAO, 2007). In Asia, Philippines lost 60%, Thailand 55%, Vietnam 37% and Malaysia 12% of their total mangroves forests (Siddiqi, 2001). About 0.110 million ha of mangroves are lost in Malaysia from 1980 to 2005 (FAO, 2007). The major threats facing by mangrove ecosystem created by humans that include overexploitation, conversion of land to residential and agriculture purposes, aquaculture, urban development, salt extraction and diversion of freshwater for irrigation (UNEP, 1994). As a result of human activities, many mangrove species are at the verge of extinction (Polidoro *et al.*, 2010). In recent years, the human impact on mangroves has increased and 50–80% forests cover have lost in many countries over the last 50 years (Macintosh *et al.*, 2011). The growing threats and human pressure on the mangrove resource make the situation complex; hence more research works are needed, especially linking human interaction with the mangrove resource and its dependency. Further ways and means are required to explore effective solutions and recommendations for tackling and reducing human pressure on this precise resource.

Worldwide, it is proven from various research studies that when the community people are benefitted from ecosystems, they themselves take care for the conservation of these ecosystems for their own benefits. In addition to that sense of ownership has been established and they started to safeguarding those resource for their own interest. Although, mangroves are the most well described and studied ecosystems of the world (Krauss *et al.*, 2014), researches on mangroves and social linkages are still lacking worldwide (Walter *et al.*, 2008). Moreover, human and social dimensions are relatively new aspect in the mangrove forests and significant regions in the world are understudied for resource utilization and valuation for mangrove forests (Walter *et al.*, 2008).

The scenario of Malaysia is not an exception, considering the global perspectives. In spite of versatile importance in regards to tangible and intangible benefits, very scarce information are available in Malaysia, especially in Sarawak, where pristine and undisturbed mangroves are found along the coastlines (Kasawani *et al.*, 2007; Wan Juliana *et al.*, 2014). Most of the researches in Malaysia are on the mangroves of Peninsular Malaysia, although Sarawak and Sabah are enriched with numerous pristine Mangroves (Saifullah *et al.*, 2014). Some partial researches were conducted on the ecological processes of Sarawak mangroves such as carbon sequestration (Chandra, 2013), water characteristics (Rosli *et al.*, 2010; Saifullah *et al.*, 2014), Soil properties (Rambok *et al.*, 2010), heavy metals in mangrove sediments (Billah *et al.*, 2014), litterfall (Hoque *et al.*, 2015b), Sediment accretion and accumulation (Hoque *et al.*, 2015a); Fish diversity and composition in the Sibuti mangrove (Hoque *et al.*, 2015c). Likewise, assessment of forest structure, species composition and diversity of the study area is very essential and important to derive benefits and services of this vital ecosystem and linking it with social and human dimension. Research scope were felt to

know the factual situation on the ground and documenting of tangible and intangible benefits and services of the mangroves as well the area were needed to be explored along with available forestry resource in terms of species composition and forest diversity.

1.3 Significance of the Study

Ecological benefits and services are the foundation of an ecosystem and are interlinked with the human interaction and their socio-economic development. Sibuti mangrove, the study area is an undisturbed mangrove forest of Sarawak (Saifullah *et al.*, 2014). So far, research on sedimentation, litter fall, fish diversity, water characteristics and nutrient dynamics are conducted by Hoque *et al.* (2015a,b,c) and Saifullah *et al.* (2014). However, the floral composition and its tangible and intangible benefits derived by the peoples are not documented and relatively ignored. Therefore, being an undisturbed and matured forest, it was hypothesized that the community people residing nearby may benefit extensively or there might have some hidden threats due to unconsciousness/unawareness of the people about the ecological and economic importance of this mangrove, which need to be explored. This work would also be highly important to bridge the gap of knowledge by linking social aspect with ecological attributes.

Likewise, the importance of community awareness and links of mangrove forests with coastal communities are evidently accepted by the researchers, government agencies and other stakeholders. Therefore, there is an essence need of research work to assess the awareness level of coastal communities and to envisage the information gap of human dimension of mangrove ecosystems particularly in Sarawak.

Consequently, considering the aforementioned knowledge gaps and recommendations of the various researchers, social linkages and ecological attributes of mangroves such as tangible and intangible benefits, community awareness regarding these benefits of mangroves as well as floral composition of pristine mangroves were emphasized for the purpose of the present study. Hence, the findings of this study would be helpful for the scientific community especially social scientists and ecologists, planners, decision makers, conservationists and the development practitioners in envisaging and formulating effective management planning considering the social and ecological significance of the concern area.

1.4 Objectives

The objectives of this study were:

- To assess the tangible and intangible benefits along with awareness level of the local community inhabits adjacent to the Sibuti mangrove forest.
- To investigate the plant composition and diversity of Sibuti mangroves forest, Sarawak.

REFERENCES

- Alexander, S.E. 2000. Resident attitude towards conservation and black howler monkeys in Belize: the community Baboon Sanctuary. *Environmental Conservation* 27 (4): 341-350.
- Alongi, D.M. 2002. Present state and future of the world's mangrove forests. *Environmental Conservation* 29 (3): 331-349.
- Ashton, E.A. and Macintosh, D.J. 2002. Preliminary assessment of the plant diversity and community ecology of the Sematan mangrove forest, Sarawak, Malaysia. *Forest Ecology and Management* 166 (2002): 111-129.
- Asihing, K., Bramasto N. Dudung, D. and Cecep, K. 2012. Integrated management of mangroves ecosystem in Lampung mangrove center (LMC) East Lampung Regency, Indonesia. *Journal of Coastal Development* 15 (2): 209- 216.
- Atmis, E., Gunsen, H.B. Lise. B.B. and Lise, W. 2009. Factors affecting forest cooperative's participation in forestry in Turkey. *Journal of Forest Policy and Economics* 11 (2): 102-108.
- Berjak, P., Campbell, G.K. Hockett, B.I. and Pammenter, N.W. 1977. The Mangroves of Southern Africa. NOAA Technical Memorandum NMFS-SEFC-261: 40.
- Bhattacharya, A.K., Jha S. and Dave, A. 2001. Biodiversity conservation and ecotourism; lessons from Sundarban tiger reserve. *Van Vigyan-Journal of Forest Science* (39): 73- 81.
- Bhattacharya, M., Bhattacharya, P. and Patra, B. 2011. SWOT Analysis of Ecotourism in the Sundarbans, West Bengal, India. Philica.com. article No. 236.
- Billah, M.M., Abu Hena, M.K., Idris, M.H., Ismail, J.B. and Bhuiyan, M.K.A. 2014. Cu, Zn, Fe, and Mn in mangrove ecosystems (sediment, water, oyster, and macroalgae) of Sarawak, Malaysia. *Zoology and Ecology* 24 (4): 380-388.
- Blomley, T., Isango, J. Zahabu, E. Ahrends, A. and Burgess N.D. 2008. Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. *Fauna & Flora International, Oryx*. 42(3): 380-391.
- Boquiren, R. Di Carlo, G. and Quibilan, M. 2010. Climate Change Vulnerability Assessment of the Verde Island Passage, Philippines. Technical Report Conservation international, Virginia.
- Buckland, S.T. 2001. *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*: New York, Oxford University Press.
- Chandra, I.A. 2013. *Above-ground Biomass and Carbon Storage in Awat Awat Mangroves Forest, Sarawak, Malaysia*, Master Thesis, University Putra Malaysia.

- Chandra, I.A., Seca, G. and Abu Hena, M.K. 2011. Aboveground biomass production of *Rhizophora apiculata* Blume in Sarawak mangrove forest. *American Journal of Agricultural and Biological Sciences* 6 (4): 469-474.
- Chansang, H. 1984. In *Structure of Mangroves Forest at Ko Yao Yai, Southern Thailand*, Proceedings of ASIAN symposium on mangroves environment research and management, Kuala Lumpur: University of Malaya.
- Chapman, V.J. 1976. *Mangrove vegetation: Vaduz* (Liechtenstein) Cramer.
- Chaudhuri, A.B. and Choudhury, A. 1994. *Mangroves of the Sundarbans Vol.(I) India*. IUCN: Bangkok, Thailand.
- Chowdhury, M., Sh.N. Hossain, M.S. Mitra, A. and Barua, P. 2011. Environmental functions of the Teknaf Peninsula mangroves of Bangladesh to communicate the values of goods and services. *Mesopotamia Journal of Marian Science* 26(1):79-97.
- Cintron, G. and Novelli, Y.S. 1984. Methods for studying mangrove structure. In: *The Mangrove Ecosystem: Research Methods*, ed. S.C. Snedaker, and J.G. Snedaker, pp. 91-113. Paris: UNESCO.
- Clough, B. 2013. *Continuing the Journey Amongst Mangroves*. International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, and International Tropical Timber Organization (ITTO): Yokohama, Japan.
- Costanza, R., D'Arge, R. De Groot, R. Farber, S. Grasso, M. Hannon, B. Linnberg, K. Naeema, S. O'Neill, R.V. Parvelo, J. Raskin, R.G. Sutton, P. and Van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.
- Cutler, J.C. 2012. *Mangroves ecology, Encyclopedia of earth*. The National Council for Science and the Environment, Washington, D.C.
- Danielsen, F., Sorensen, M.K. Olwig, M.F. Selvam, V. Parish F. Burgess, N.D. Hiralshi, T. Karunakaran, V.M. Rasmussen, M.S. Hansen, L.B. Quarto, A. and Suryadiputra, N. 2005. The Asian tsunami: a protective role for coastal vegetation. *Science* 310 (5748): 643.
- David, B.W. 1999. Magnitude of ecotourism in Costa Rica and Kenya. *Annals of Tourism Research* 26 (4): 792-816
- Diaz, R.J. and Rosenberg, R. 2008. Spreading dead zones and consequences for marine ecosystems. *Science* (321). 926-929.
- Dixon, J.A. 1989. The value of mangrove ecosystems. *Tropical Coastal Area Management Newsletter* 4: 5-8.
- Duarte, C.M. Borum, J. Short, F.T. and Walker, D.I. 2005. Seagrass Ecosystems: Their Global Status and Prospects, In *Aquatic Ecosystems: Trends and Global Prospects*, ed. N.V.C. Polunin, Cambridge University Press.

- Elizabeth, L.T. and Colin, J.R. 1993. The value of a mangrove area in Sarawak. *Biodiversity and Conservation* (2): 359-375.
- Ellison, J.C. 2012. *Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems*. Washington, DC: World Wildlife Fund (WWF).
- FAO, (2002). Non-Wood Forest Products in 15 countries of tropical Asia An overview; FAO Regional Office for Asia and the Pacific 39 Phra Atit Road Bangkok 10200 Thailand. pp.22.
- FAO, 1994. Mangrove Forest Management Guidelines FAO paper 117.
- FAO, 2007. The world's mangroves 1980–2005: A thematic study in the framework of the global forest resources assessment 2005. Rome, paper 153: Pp 1–74.
- Faridah-Hanum, I., Kamziah A.K. and Nurul, S.S. 2012. Plant diversity and biomass of Marudu Bay mangroves in Malaysia. *Pakistan Journal of Botany* 44: 151-156.
- Fleming, M. Lin, G. and Sternberg, L. 1990. Influence of mangrove detritus in an estuarine ecosystem. *Bulletin of Marine Science* 47: 663-669.
- Franks, T. and Falconer, R. 1999. Developing procedures for the sustainable use of mangrove system. *Agricultural Water Management* (40): 59-64.
- Friess, D.A., Krauss, K.W. Horstman, E.M. Balke, T. Bouma, T.J. Galli, D. and Webb, E.L. 2012. Are all intertidal wetlands naturally created equal? Bottlenecks, thresholds and knowledge gaps to mangrove and saltmarsh ecosystems. *Biological Review* 87: 346–366.
- Gan, B.K. A working plan for the Matang mangrove forest reserve (forth revision). The State Forest Department of Perak darul ridzuan: Malaysia. 1995.
- Gandaseca, S., Rosli, N. Ngayop, J. and Chandra, I.A. 2011. Status of water quality based on the physico chemical assessment on river water at wildlife sanctuary Sibuti, mangrove forest, Miri Sarawak. *American Journal of Environmental Science* 7(3): 269-275.
- Garcia, K.B. Malabrigo Jr., P.L. and Gevaña, D.T. 2014. Philippines' Mangrove Ecosystem: Status, Threats and Conservation. In *Mangrove Ecosystems of Asia Status, Challenges and Management Strategies*, ed. I. Faridah-Hanum, A. Latiff, K. R. Hakeem and M. Ozturk, pp 81-94. Springer New York Heidelberg Dordrecht London.
- Giri, C., Ochieng, E. Tieszen, L.L. Zhu, Z. Singh, A. Loveland, T. Masek, J. and Duke, N. 2011. Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography* 20: 154–159.
- Gopal B., *Water and Biodiversity*. UP State Biodiversity Board, Lucknow, India. 2013.
- Haliza, A.R. Sarah, A. Mokhtar, M. and Latiff, A. 2005. Perundangan yang berkaitan ekosistem hutan paya bakau di Selangor. In *Sustainable management of Matang mangroves 100 years and beyond*. *Forest biodiversity series, vol 4*, ed. M.I.

- Shaharuddin, A. Muda, R. Ujang, K.A. Budin, K.L. Lim, S. Rosli, M.S. Jalil, A. Latiff. Pp. 127-138. Forestry Department Peninsular Malaysia, Kuala Lumpur.
- Harada, K. Imamura, F. and Hiraishi, T. 2002. Experimental study on the effect in reducing Tsunami by the coastal permeable structures, Final Proc. Int. Offshore Polar Eng. Conf., USA. pp. 652-658.
- Harakunarak, A. and Aksornkoae, S. 2005. Life saving belts: Post-tsunami reassessment of mangrove ecosystem values and management in Thailand. *Tropical Coasts* 48-55.
- Hirani, P. 2005. Ethno-ecological Study of the Mangroves of the Tanbi Wetland Complex, The Gambia, Vrije University, Brussel.
- Hoque MM, Abu Hena MK, Ahmed OH, Idris MH, Hoque ATMR, Billah MM. 2015a. Can Mangroves Help Combat Sea Level Rise Through Sediment Accretion and Accumulation? *Malaysian Journal of Science* 34(1): 23-30.
- Hoque MM, Abu Hena MK, Idris MH, Ahmed OH, Hoque ATMR, Billah MM. 2015b. Litterfall production in a tropical mangrove of Sarawak, Malaysia. *Zoology and Ecology* 25 (2): 157-165.
- Hoque. M.M., Abu Hena MK, Idris MH, Ahmed OH, Saifullah ASM, Billah MM. 2015c. Status of some fishery resources in a tropical mangrove estuary of Sarawak, Malaysia. *Marine Biology Research*. (DOI: org/10.1080/17451000.2015.1016970).
- Hossain, M. 2004. *Biomass, Litter Production and Selected Nutrients in Bruguiera parviflora (Roxb.) weight and area. Dominated Mangrove Forest Ecosystem at Kuala Selangor, Malaysia*. PhD. Thesis, University Putra Malaysia.
- IFRC. World Disasters Report, Focus on Reducing Risk, Geneva, 2002.
- Iftekhar, M.S. and Takama, T. 2008. Perceptions of biodiversity, environmental services and conservation of planted mangrove: A case study on Nijhum Dwip Island, Bangladesh. *Wetlands ecology Management* 119-137.
- International Labor Office, *Raising Awareness of Forests and Forestry Building Bridges between People, Forests and Forestry*; Report of the FAO/ECE/ILO Team of Specialists on Participation in Forestry and the FAO/ECE Forest Communicators Network. pp.1-13. CH-1211 Geneva 22, Switzerland, International Labour Office, 2003.
- Inkyin, K., Su, Y.W. and Hoduck, K. 2014. A study of the role of forest and forest-dependent community in Myanmar. *Forest Science and Technology* 10(4):197-200.
- IUCN, 2002. Sustainable Tourism in Protected Areas Guidelines for Planning and Management. IUCN, Gland, Switzerland.

- Julia, N. Hardawati, Y. and Nur, M. 2013. Forest use rights and community awareness; A case study of Kawang forest reserve, Sabah. In international symposium on tropical forest ecosystem science and management Proceeding. Pp. 186-195.
- Julia, N., Hardawati, Y. Chowdhury, M.S.H. and Nur, M. 2014. Indigenous community awareness and rights to forest in Kawang Forest Reserve, Sabah, Malaysia. *International Journal of Sustainable Development & World Ecology* 21(2):127-137.
- Kamaruzaman, J. and Dahlan, T. 2008. Managing sustainable mangrove forests in Peninsular Malaysia, *Journal of Sustainable Development* (1)1.
- Kapetsky, J.M. 1985. Mangroves, fisheries and aquaculture. FAO Fisheries Report 338. Rome.
- Kapoor, N. 2011. Role of mass media in promotion of environmental awareness along with skill development among the rural people of Shringverpur, Allahabad District, India. In: International Conference on Chemical, Biological and Environment Sciences (ICCEBS'2011); 2011 Dec; Bangkok.
- Kathiresan, K. 2000. Flora and Fauna in mangroves: A manual for identification. Ministry of Environment and forests, CAS in Marine Biology, Parangipettai, India.
- Kathiresan, K. 2012. Importance of mangrove ecosystem. *International Journal of Marine Science* 2(10): 70-89.
- Kathiresan, K. and Bingham, B.L. 2001. Biology of mangrove and mangrove ecosystems. *Advances in Marine Biology* 40: 81-251.
- Kathiresan, K. and Rajendran, N. 2005. Coastal mangrove forests mitigated tsunami. *Estuarine coastal and Shelf Science* 65(3): 601-606.
- Kasawani, I., Kamaruzaman, J. and Nurun-Nadhirah, M.I. 2007. Biological diversity assessment of Tok Bali mangrove forest, Kelantan, Malaysia. *WSEAS Transaction on Environment and Development* 2: 37-44.
- Kjerfve, B. and Macintosh, D.J. 1997. Mangrove Ecosystem Studies in Latin America and Africa. UNESCO, Paris. pp. 1-7.
- Krauss, K.W., McKee, K.L., Lovelock, C.E., Cahoon, D.R, Saintilan, N., Reef, R. and Chen, L. 2014. How mangrove forests adjust to rising sea level: Tansley review. *New Phytologist* 202: 19-34.
- Krishnamurthy, K. 1990. The apiary of mangroves. In *Wetland Ecology and Management: Case Studies*, ed. D.F. Whigham, D. Dykyjovya, and S. Hejnyeds. pp. 135-140. Netherlands: Kluwer Academic press.
- Kusmana, C. Istomo Cahyo, W. Sri Wilarso, B.R. Iskandar, Z.S. Tatang, T. and Sukristijono, S. 2008. Manual of mangrove silviculture in Indonesia. Directorate General of Land Rehabilitation and Social forestry, Ministry of Forestry and Korea International Cooperation.

- Latiff, A. and Faridah-Hanum, I. 2014. Mangrove Ecosystem of Malaysia: Status, Challenges And Management Strategies. In *Mangroves Ecosystems in Asia; Status, Challenges and Management Strategies*, ed. I. Faridah-Hanum, A. Latiff, K. R. Hakeem and M. Ozturk, pp 1-17. Springer New York Heidelberg Dordrecht London.
- Lucy, E. 2006. Counting mangrove ecosystems as economic components of Asia's coastal infrastructure. In: Proceedings of International Conference and Exhibition on Mangroves of Indian and Western Pacific Oceans (ICEMAN 2006), Aug. 21-24, 2006, Kuala Lumpur, pp.1-14.
- Macintosh, D.J. Epps, M.M. and Abrenilla, O. 2011. Ecosystem approaches to coastal resources management: the case for investing in mangrove ecosystems. In *Food for all Investing in Food Security in Asia and the Pacific—Issues, Innovations, and Practices*. pp. 140-155. Asian Development Bank: Philippines.
- MacNae, W. 1968. A general account of the fauna and flora of mangrove swamp and forest in the Indo-West pacific region. *Advance Marine Biology* 6:73–270.
- Mamoon, W.M. and Iftihar, A. 2008. Economic importance and impacts of Indus delta mangrove forests on local communities. *The Pakistan Journal of Forestry* 58(2): 77-93.
- Mazda, Y., Magi, M. Kogo, M. and Hong, P.N. 1997. Mangrove on coastal protection from waves in the Tong King Delta, Vietnam. *Mangroves and Salt Marshes* 1: 127-135.
- McLeod, E. and Salm, R.V. 2006. Managing Mangroves for Resilience to Climate Change. IUCN, Gland, Switzerland.
- Moorthy, P. and Kathiresan, K. 1997. Photosynthetic pigments in tropical mangroves: Impacts of seasonal flux on UV-B radiation and other environmental attributes, *Botanica Marina* 40: 341-349.
- Morrisey, D.J. Swales, A. Dittmann, S. Morrison, M.A. Lovelock, C.E. and Beard, C.M. 2010. The ecology and management of temperate mangroves. *Ocean and Marine Biology: Annual Review* 48:43–160.
- Murofushi, T. Chiew, F.C.Y. Wat, Y.H. Miyagi, T. Mochida, Y. Fujimoto, K. and Ishihara, S. 1999. Mangrove forest dynamics in relation to sediment input at the mouth of Sematan river, Sarawak, Malaysia. *Tropics* 8: 275-289.
- Naidoo, G. 2009. Different effects of nitrogen and phosphorus enrichment on growth of dwarf *Avicennia Marina* Mangroves. *Aquatic Botany* 90:184–190
- Norhayati, A. 1995. *Biomass and Species Composition of Mangrove Forest Pulau Langkawi*. MSc. Thesis, Universiti Kebangsaan Malaysia.
- Noske, R.A. 1996. Abundance, zonation and feeding ecology of birds in mangroves of Darwin harbour, Northern Territory. *Wild Research* 23:443–474.

- Nyanti, L., Ling, T.Y. and Jongkar, G. 2012. Fish and crustacean communities and fish length-weight relationship of Lutong river, Miri, Sarawak, Malaysia. *World Journal of Fish and Marine Science* 4:102–110.
- Pallardy, S.G. 2008. *Physiology of Woody Plants (3rd ed.)*: Academic Press, Columbia.
- Paul, P.K.C. 1975. Field key to the mangrove trees and shrubs occurring in Sarawak: Including a brief description of the flora. Sarawak Forestry Department.
- Pillay, T. 2004. *Aquaculture and the Environment*: Wiley-Blackwell, UK.
- Polidoro, B.A. Carpenter, K.E. Collins, L. Duke, N.C. and Ellison, A.M. 2010. The Loss of Species: Mangrove extinction risk and geographic areas of global concern. *Plos One* 5(4).
- Primavera, J.H. 2013. Prawn Shrimp Culture Industry in the Philippines. In *Marine shrimp culture: Principles and Practices*, ed. A.W. Fast and L.J. Lester, pp.701-728. Amsterdam, The Netherlands: Elsevier Science.
- Qasim, S.Z. 1998. Mangroves, In: *Glimpses of the Indian Ocean*, University Press, pp.123-129, Hyderabad, India.
- Rabalais, N.N. and Gilbert, D. 2009. Distribution and consequences of hypoxia. In *Watersheds, Bays, and Bounded Seas: The Science and Management of Semi-Enclosed Marine Systems*. ed. E.R. Jr. Urban, B. Sundby, P. Malanotte-Rizzoli, and J. Mellilo, volume 70 of Scientific Committee on Problems of the Environment (SCOPE) Series, 70: 209-225.
- Rajpar MN and Zakaria M. 2014a. Assessing the effects of logging activities on avian richness and diversity in different aged post-harvested hill Dipterocarp tropical rainforest of Malaysia. *American Journal of Applied Science* 11: 1519-1529.
- Rajpar, M.N. and Zakaria, M. 2014b. Mangrove Fauna of Asia. In *Mangrove Ecosystems of Asia Status, Challenges and Management Strategies*, ed. I. Faridah-Hanum, A. Latiff, K. R. Hakeem and M. Ozturk, pp 153-190. Springer New York Heidelberg Dordrecht London.
- Rambok, E., Gandaseca, S. Ahmed, O.H. and Majid, N.M.A. 2010. Comparison of selected soil chemical properties of two different mangrove forests in Sarawak. *American Journal of Environmental Science* 6: 438-441.
- Rodriguez, W. and Feller, I.C. 2004. Mangrove landscape characterization and change in Twin Cays, Belize using aerial photography and IKONOS satellite data. *Atol Research Bulletin* 509:1–22.
- Rosli, N., Gandaseca, S., Ismail, J. and Jailan, M.I. 2010. Comparative study of water quality at different peat swamp forest of Batang Igan, Sibul Sarawak. *American Journal of Environmental Sciences* 6: 416-21.
- Rotaquio Jr, E.L. Nakagoshi, N. and Rotaquio, R.L. 2007. Species composition of mangrove forests in Aurora, Philippines-A special reference to the presence of

- Kandelia Candel* (L.) Druce. *Journal of International Development Cooperation* 13:61–78.
- Ryan, C., Hughes, K. and Chirgwin, S. 2000. The gaze, spectacle and Ecotourism. *Annals of Tourism Research* 27(1): 148-163.
- Saenger, P. 2002. *Mangrove Ecology, Silviculture and Conservation*. Dordrecht, Netherlands: Kluwer Academic Publishers.
- Saenger, P., Hegerl, E.J. and Davie, J.D.S. 1983. Global status of mangrove ecosystems. *The Environment* 3:1–88.
- Saifullah, A.S.M., Abu Hena, M.K. Idris, M.H. Rajae, A.H. and Johan, I. 2014. Seasonal variation of water characteristics in Kuala Sibuti river estuary in Miri, Sarawak, Malaysia. *Malaysian Journal of Science* 33(1):9-22.
- Sandilyan, S. and Kathiresan, K. 2012. Mangrove conservation: a global perspective. *Biodiversity Conservation* 21: 3523–3542.
- Seaby, R.M. and Henderson, P.A. 2006. *Species Diversity and Richness Version 4.0*. England: Pisces Conservation Ltd., Lymington.
- Seaby, R.M. and Henderson, P.A. 2007. *Community Analysis Package version 4.0*. England: Pisces Conservation Ltd., Lymington.
- Sharon, Y.J.F. Ahmad, S. and Salbiah, E. 2011. Estimation of total economic value of the deltaic mangrove forest resource in the District of Kuching; working paper Series No. 1104. Faculty of Economic and Business, Universiti Malaysia Sarawak (UNIMAS).
- Shukor, A.H. 2004. The use of mangroves in Malaysia. In: Promotion of mangrove-friendly shrimp aquaculture in Southeast Asia (pp. 136-144). Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.
- Siddiqi, N.A. 1997. Management of Resources in the Sunderbans Mangroves of Bangladesh, International News letter of coastal Management-Inter coast Network. Special edition, 1: 22-23.
- Siddiqi, N.A. 2001. *Mangrove Forestry in Bangladesh*. Chittagong, Bangladesh: Institute of Forestry, University of Chittagong.
- Singh, A., Bhattacharya, P. Vyas, P. and Roy, S. 2010. Contribution of NTFPs in the livelihood of mangrove forest dwellers of Sundarban. *Journal of Human Ecology* 29(3):191-200.
- Snedaker, S.C. 1978. Mangroves: Their value and perpetuation. *Nat Res* 14:6–13.
- Spalding, M. Kainuma, M. and Collins, L. 2010. *World Atlas of Mangroves*. Earthscan London, UK.

- Stafford-Deitsch, J. 1996. *Mangrove: The Forgotten Habitat*. London: IMMEL Publishing Limited.
- Suh, J. and Emtage, N. F. 2005. Identification of Strengths, Weaknesses, Opportunities and Threats of the community-based forest management program. *Annals of Tropical Research* 27(1): 55-66
- Tangah, J. 2005. Management and conservation of mangroves: Sabah experience. In *Sustainable Management of Matang Mangroves 100 years and beyond. Forest Biodiversity Series, Vol 4*, ed. M.I. Shaharuddin, A. Muda, R. Ujang, K.A. Budin, K.L. Lim, S. Rosli, M.S. Jalil, A. Latiff, pp.53-57. Forestry Department Peninsular Malaysia, Kuala Lumpur.
- Tomlinson, P.B. 1986. *The Botany of Mangroves*. Cambridge: University Press.
- Twilley, R.R. 1995. Properties of Mangrove Ecosystems related to the Energy Signature of Coastal Environments. In *Maximum Power: The Ideas and Application*, ed. C.A.S. Hall and H.T. Odum, Colorado: University of Colorado Press, Boulder.
- Twilley, R.R. Chen, R. and Hargis, T. 1992. Carbon sinks in mangroves and their implication to carbon budget of tropical ecosystems. *Water, Air and Soil Pollution* 64: 265-288.
- Uddin, S.M.M., Hoque, A.T.M.R. and Abdullah, S.A. 2014. Changing landscape of mangrove in Bangladesh and its comparison with other four countries in tropical region. *Journal of Forest Research* 25(3): 605-611.
- United Nations Environment Program. *Abstract of human development reports. United Nations Development Programme*: 2009.
- United Nations Environment Program. *Assessment and monitoring of climatic change impacts on mangrove ecosystems*. UNEP Regional Seas Reports and Studies. Report No. 154: 1994.
- Vannucci, M. 2002. Indo-west pacific mangroves. In *Mangrove ecosystems*, ed. L.D. Lacerda, pp. 123-215. Berlin Verlag: Springer.
- Viswanathan. P.K. Pathak Kinjal, D. and Mehta, I. 2011. Socio-economic and ecological benefits of mangrove plantation: A study of community based mangrove restoration activities in Gujarat. Gujarat Ecology Commission (GEC), Government of Gujarat, Gandhinagar, Ahmedabad.
- Wafar, S. Untawale, A.G. and Wafar, M. 1997. Litter fall and energy flux in a mangrove ecosystem. *Estuarine, Coastal and Shelf Science* 44: 111-124.
- Wah, L.M. Mojiol, A.R. and Saleh, E. 2011. Diversity of mangroves ecosystem in Semporna mangrove forest. *Borneo Science* 28: 8-17.
- Walter, B.B. Ronnback, P. Kovacs, J.M. Crona, B. Hussain, S.A. Badola, R. Primavera, J.H. Barbier, H. and Dahdouh-Guebas, F. 2008. Ethnobiology, socio-

economic and management of mangrove forests: a review. *Aquatic Botany* 89: 220-236.

- Wan Juliana, W.A. Damanhuri, A. Razali, M.S. Norhayati, A. and Latiff, A. 2010. *Mangrove Flora of Langkawi*. Langkawi research centre, Institute for Environment and Development (LESTRI), Universiti Kebangsaan Malaysia, and Langkawi development (LDA).
- Wan Juliana, W.A. Razali, M.S. and Latiff, A. 2014. Distribution and rarity of Rhizophoraceae in Peninsular Malaysia; In *Mangrove Ecosystems of Asia Status, Challenges and Management Strategies*, ed. I. Faridah-Hanum, A. Latiff, K. R. Hakeem and M. Ozturk, pp-24-34. Springer New York Heidelberg Dordrecht London.
- Wells, S. Ravilious, C. and Corcoran, E. 2006. *In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs*. UNEP-WCMC: Cambridge, UK.
- Wong, Y.S., Lam, C.Y. Che, S.H. Li, X.R. and Tam, N.F.Y. 1995. Effect of wastewater discharge on nutrient contamination of mangrove soil and plants. *Hydrobiologia* 295: 243-254.
- Zhou, Y. Zhao, B. Peng, Y. and Chen, G. 2010. Influence of mangrove reforestation on heavy metal accumulation and speciation in intertidal sediments. *Marian Pollution Bulletin* 6:1319–1324.

BIODATA OF STUDENT

Kaleem Shah was born on 1st March 1975 at Nowshera, Khyber Pakhtunkhwa, Pakistan. He acquired his Secondary School Certificate from Board of Intermediate and Secondary Education, Peshawar Pakistan in 1991. Then, he passed his Intermediate Secondary School examination from Board of Intermediate and Secondary Education, Peshawar in 1993. After passing Intermediate Secondary School examination, he has been registered at University of Peshawar, Pakistan for his Bachelor Degree program major in Computer Science, Mathematics and Islamic studies. He was awarded his bachelor degree in 1997. Subsequently, he achieved his Master degree from University of Peshawar during 1999-2000.

He started his professional life in 2001 by joining Forest Department Govt. of Khyber Pakhtunkhwa, Pakistan as Community Development Officer. In 2002, he has been appointed as Assistant Director at Research and Development Directorate and since then, he is working in Forest Department on the same post. He worked on different forestry related issues as per his job description and duty assigned to him. Now, he is on study leave from job for his studies.

He has been enrolled as a full time Master Student in Forestry at Faculty of Agriculture and Food Sciences, UPMKB during 2013-14 semesters. During his postgraduate study at UPMKB, he has submitted a research article titled “Composition and diversity of plant in Sibuti Mangrove forest, Sarawak, Malaysia”.

PUBLICATION

Shah K., Abu Hena M.K., Zamri R., Hakeem K.R. and Hoque M.M, 2015.
Composition and Diversity of Plant in Sibuti Mangrove Forests, Sarawak,
Malaysia. *Forest Science and Technology*,
(DOI.10.1080/21580103.2015.1057619).

