ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

VEGETATION ANALYSIS AND COMMUNITY STRUCTURE OF MANGROVES IN ALABEL AND MAASIM SARANGANI PROVINCE, PHILIPPINES

Ella Mae C. Natividad[1], Vivian S. Hingabay[1], Harold B. Lipae[1], Elani A. Requieron[2], April Joy Abalunan[2], Paolo M. Tagaloguin[2], Remedios S. Flamiano[2], Jess H. Jumawan[2] and Joycelyn C. Jumawan[3]
[1]Division of Biology, College of Natural Sciences and Mathematics, Mindanao States University, General Santos City Campus, Fatima, General Santos City, Philippines
[2]Department of Science, College of Natural Sciences and Mathematics, Mindanao States University, General Santos City Campus, Fatima, General Santos City, Philippines;
[3]Department of Biology, Caraga State University, Butuan, Philippines
Email: ellamaenatividad18@yahoo.com

ABSTRACT

The study was conducted in order to establish and describe the mangrove community and vegetation of the mangrove forest in Alabel and Maasim, Sarangani province. It was evident that the studies for mangrove vegetation were really few in Sarangani bay. Thus, this study will serve as baseline information. Sampling plots (10m x 10m) were established into sea ward, middle ward and landward. Individual plants found within the plot were identified and counted. Mangrove vegetation analyses were determined using relative density, relative frequency, relative dominance and importance value. Community structure was analysed using multivariate analysis performing non-metric multi-dimensional scaling (nMDS), cluster analysis and one way ANOSIM. Mangrove communities in Alabel and Maasim, Sarangani province have identified 12species; *A. marina, L. racemosa, P. acidula, A. floridum, X. granatum, B. gymnorrhiza, B. cylindrical, C. decandra, C. tagal, R. apiculata, R. mucronat andS. alba* out of 39 true mangroves reported in the Philippines. Vegetation analysis in Alabel showed that species with the highest importance value was*A. marina* (84.72%) and *S. alba* (158.72%) in Maasim sampling site. Cluster analysis showed moderate similarity among plots observed from the same site than plots from different sites. All the 21 sampling plots in Alabel and 20 in Maasimwere clustered based on similarities and formed into 3 groups with 40% similarity. Data ordination in nMDS revealed that characteristic similarity of same sites was analogous with ANOSIM of (R=0.317, P=0.001) but very minimal similar characteristics were observed in Alabel sampling plots to Maasim sampling plots. Results shows *A. marina* and *S. alba* as species with highest importance value with mangrove structure showing no distinct characteristics on the two sites.

Keywords: mangrove, vegetation analysis, community structure, Sarangani Province, Philippines.

INTRODUCTION

According to Primavera and Esteban [1], Philippines is an archipelago having 7,100 islands and was bordered by 36,300 km of coastline along mangrove forests, sea grass beds and coral reefs. Mangroves are salt tolerant trees and shrubs that grow within the sheltered marine intertidal zones of the tropics and subtropics. As a whole community, mangroves are capable of thriving in a wide range of harsh environmental conditions and share unique adaptive traits [2]. Much of the uses of mangroves were not only economic but wide range of ecological services. Kathiresan [3] discussed that mangroves protects the coast from solar UV-B radiation, 'green house' effects, and fury of cyclones, floods, sea level rise, wave action and coastal erosion. They constitute a taxonomically diverse collection of several unrelated angiosperm families with special adaptations [4, 5]. Bonan [6] discussed that forests are a crucial ecological resource; they are responsible for preserving biodiversity, maintaining soil fertility, regulating water resources, sustaining economic activitiesand supporting geochemical and climatological cycles. Thus, according to Gillis [7], estimating the amount of forest cover over large areas is important for many reasons. Quantifying forest cover is a necessary input for studies linking changes inforests with natural and anthropogenic events [8].

Vegetation analysis is the way to study species composition and structure of plant community. Walsh [9] described the mangrove ecosystem as a unique type of forest characterized by its highly specialized vegetation and a typical and limiting environment. The distributions of individuals within it, as well as factors which have molded this habitat have become a recurrent concern in studies on mangrove ecology. Field-based techniques for monitoring forest cover provide the most detailed and accurate information about the condition of forests. However, these studies were expensive and limited to smaller regions of interest, or undertaken at irregular time intervals that are why only few attempted to study analysis of vegetation. To analyze the vegetation of the mangrove forest in each site, the relative dominance, and relative population density, relative population frequencies were computed. Two sampling sites were considered as a parameter for the study: Maasim and Alabel, Sarangani Province. The association patterns on distribution in terms of abundance were analyzed to know the mangrove community structure in which the sampling plots of two sampling sites were compared. It was evident that the studies for mangrove vegetation were really few in

ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

Sarangani bay. Studies for mangroves in Sarangani Province only came from the anecdotal reports of the local government unit and unpublished thesis papers from the universities in Mindanao area. It is recognized that the concentration of the published research articles regarding mangroves were concentrated only in Northern Philippines. Thus, this study will provide baseline information regarding the condition of the mangrove forest in Sarangani Province. This study analyzes the mangrove's vegetation and community structure of the mangrove forest. Appropriate statistical tools were used to discover the environmental parameters.

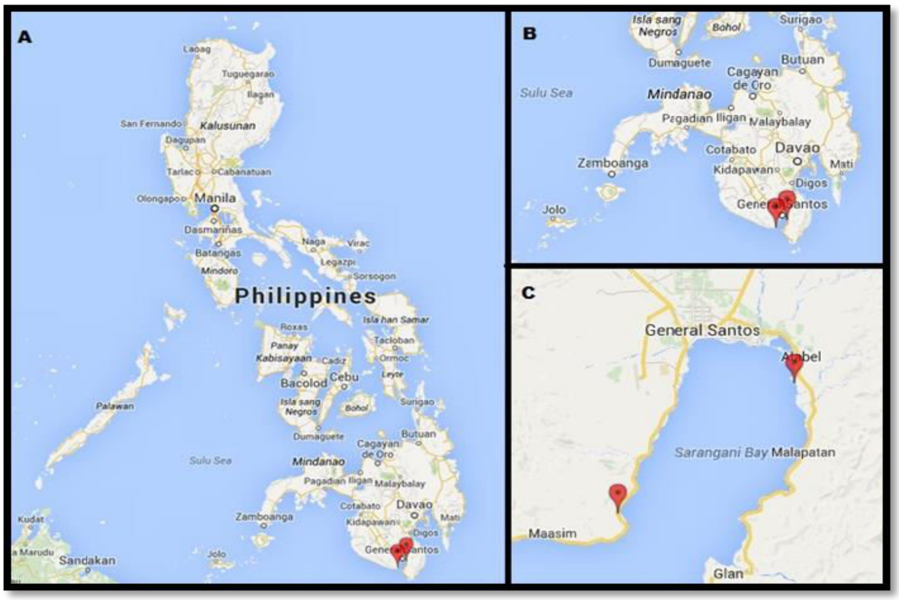

Figure-1. (A) Map of the Philippines, (B) Map showing Mindanao area, (C) Map showing the locations of the sampling sites in Maasim and Alabel, Sarangani Province. [10].

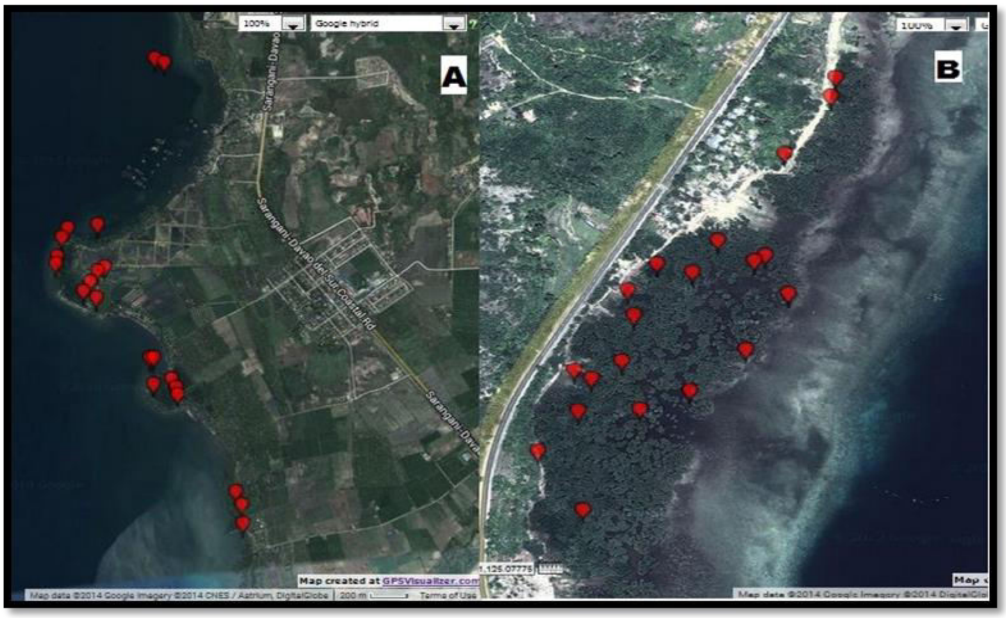

Figure-2. Sampling plots in (A) Alabel and (B) Maasim, Sarangani Province [11].

RESEARCH METHODOLOGY

Study area

Sarangani Province is located at southeastern Mindanao (Figure-1B) geographically lies between 5°33`25" - 6°6`15"N and 124°22'45"- 125°19`45"E. Two different locations in the province were chosen for the study conduct namely Alabel 06°03'04 -125°16'31 and Maasim 05°53'31-125°04'32 (Figure-1C). Mapping of sampling plots in each sampling areas were obtained through Global Positioning System (GPS) by the use of an online mapping (Figure-2).

Establishment of sampling plots and measurements

A purposive sampling was employed in the study. Sampling plots measuring 10x10 meter were set-up to areas with sufficient mangrove cover along the land ward, middle ward and sea ward. Mangroves trees inside the sampling plots were counted and identified respectively. Basic vegetation parameterswere measured for each identified species: (a) diameter at breast height (dbh) in cm, (b) basal area in m, (c) density.

Vegetation analysis

The data gathered was analysed using the parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance and the importance value (IV) [12, 13, 14, 15, 16]. This kind of analysis provides a better index than density alone regarding the importance or function of a species in its habitat. It also gives rank or order for a particular species within the forest community.

Population density = Number of individuals/ total area sampled

Frequency = Number of plots in which a species occurs/ Total number of plots sampled

Dominance = total of basal area of each tree of a species from all plots/total area of all the measured plots

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 (IV) = relative density + relative frequency + relative dominance.

Community structure

In computing multivariate analysis of mangrove community data, PRIMER software version 6 was used (Clarke1993). The data on abundance was square root transformed. The transformed data was used to construct a similarity matrix using Bray Curtis index. The resulting matrix was employed in the non-metric multi-dimensional scaling (nMDS) ordination, cluster analysis and one way analysis of similarities (ANOSIM).

Cluster analysis: According to Falcaro and Pickles [17], this analysis was performed to provide hierarchical clustering of observations applied to coordinate data or distance data. The dendrogram, which was used as a representation was used to graphically present the information concerning which observations were grouped together at various levels of similarity. At the bottom of the dendrogram, each observation was considered its own cluster. Vertical lines extend up for each observation and at various (dis) similarity values where long vertical lines indicate more distinct separation between the groups and shorter lines indicate groups that are not as distinct.

Non-metric multi-dimensional scaling (nMDS) ordination: The nMDS is used to graphically represent relationships between objects in multidimensional space. The objects were represented on a plot with the new variables as axes and the relationship between the objects on the plot should represent their underlying similarity [18].

ANOSIM (Analysis of similarities): Clarke [19] described this technique as a summarized pattern in species composition and environmental variables; permutation-based hypothesis testing (ANOSIM), an analogue of univariate ANOVA which tests for differences between groups of (multivariate) samples from different times, locations, experimental treatments etc.

RESULTS AND DISCUSSIONS

Twelve (12) mangrove species were identified in the two sampling sites of Sarangani Province. There were primarily six (6) families having nine (9) species present in Alabel and four (4) families having (6) species present in Maasim, Sarangani Province. The family Rhizophoraceae have 6 species, the highest in a family of mangroves. Mangrove species observed outside the plots were *P. acidula, B. cylindrical* and *C. decandra.* Collectively, among the mangroves found in the two sites were the following: *A. marina, L. racemosa, P. acidula, A. floridum, X. granatum, B. gymnorrhiza, B. cylindrical, C. decandra, C. tagal, R. apiculata, R. mucronata and S. alba.* Mangrove communities in Alabel and Maasim, Sarangani province have considerably few species Table-1. Sinfuego and Buot [20] say that only 12 were observed in the sampling sites of the 39 true mangroves reported in the Philippines.

Table-1. Species inventory of mangroves in Alabel and Maasim, Sarangani Province.

Family		Species	
A	*Avicenniaceae*	1	*Avicennia marina*
B	*Combretaceae*	2	*Lumnitzeraracemosa*
C	*Lythraceaeae*	3	*Pemphisacidula***
D	*Myrsinaceae*	4	*Aegicerasfloridum*
E	*Meliaceae*	5	*Xylocarpusgranatum*
F	*Rhizophoraceae*	6	*Bruguieragymnorrhiza*
		7	*Bruguieracylindrica***
		8	*Ceriopsdecandra***
		9	*Ceriopstagal*
		10	*Rhizophoraapiculata*
		11	*Rhizophoramucronata*
G	*Sonneratiaceae*	12	*Sonneratia alba*

**Mono-standing mangroves observed outside the sampling plot

Vegetation analysis in Alabel

Table-2 shows the vegetation analysis of mangroves in Alabel sampling site. It has been shown that the species having the highest relative population densities (RPD) were*A. marina* (30.50%) and *R. apiculata* (23.00%) while *L. racemosa*got the lowest with (0.94%). The species with the highest relative population frequencies (RPF) were *A. marina, S. alba* (23.44%) and *R. apiculata* (21.87%) while the lowest is still *L. racemosa* (1.56%). Species having the highest relative dominance (RDOM) was *S. alba*(33.29) and *A. marina* (30.78%) while the lowest is *C. tagal* (1.38%). The species having the highest importance value (IV) were *A. marina* (84.72%) followed by *S. alba* (76. 45%), *R. apiculata* (61.32%), *A. floridum* (40.04%), *R. mucronata* (27.85%), *C. tagal* (5.92%) and the species having the lowest importance value *L. racemosa* having (4.21%).

The concept of 'Important Value Index (IVI)' has been developed for expressing the dominance and ecological success of any species, with a single value, (Mishra, 1968). This index utilizes three characteristics: relative frequency, relative density and relative abundance.

Table-2. Values on vegetation analysis of Mangroves species in Alabel, Sarangani province.

Species	RPD	RPF	RDOM	SIV
Aegiceras floridum	15.90%	14.06%	10.08%	40.04%
Avicennia marina	30.50%	23.44%	30.78%	84.72%
Ceriops tagal	1.41%	3.13%	1.38%	5.92%
Lumnitzera racemosa	0.94%	1.56%	1.71%	4.21%
Rhizophora apiculata	23.00%	21.87%	16.45%	61.32%
Rhizophora mucronata	8.45%	12.50%	6.90%	27.85%
Sonneratia Alba	19.72%	23.44%	33.29%	76.45%

Vegetation analysis in Maasim

Table-3 shows the vegetation analysis in Maasim sampling site. *S. alba* (48.39%) was the species having the highest RPD followed by *R. mucronata* (29.03%) and the lowest RPD among six species were *X. moluccensis* and *B. gymnorrhiza* (0.65%). The species having the highest RPF were *S. alba* (44.44%) followed by *R. muconata* (33.33%) and the lowest still *X.moluccensis* and *B. gymnorrhiza* (5.56%). The highest RDOM is still *S. alba* (65.89%) followed by *R. mucronata* (17.22%) and the lowest as *B. gymnorrhiza* (0.23%). It is evident that the highest importance value among the species listed is *S. alba* (158.72%) having dominated the highest relative population density, frequency and relative dominance followed by *R. mucronata*(79.58%), *R. apiculata* (44.39%), *A. marina* (8.86%), *X. moluccensis* (4.80%) and the lowest IV value *B. gymnorrhiza* (3.66%).

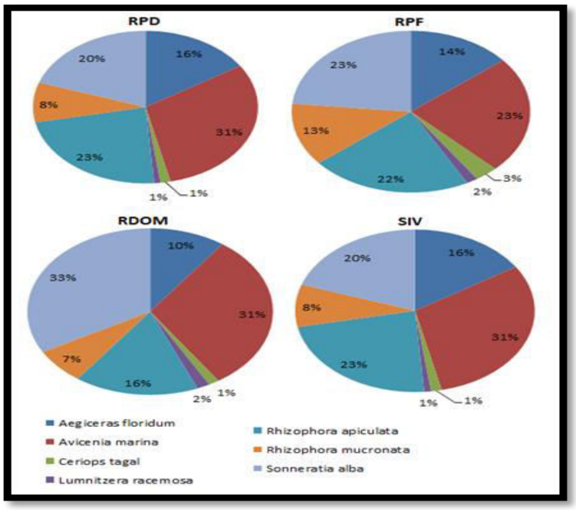

Figure-3. Chart percentage showing the vegetation values in Alabel, Sarangani Province.

Table 3. Values on vegetation analysis of Mangroves species in Maasim, Sarangani province.

Species	RPD	RPF	RDOM	SIV
Avicennia marina	1.94%	5.56%	1.36%	8.86%
Bruguiera gymnorrhiza	0.65%	2.78%	0.23%	3.66%
Rhizophora apiculata	19.35%	11.11%	13.93%	44.39%
Rhizophora mucronata	29.03%	33.33%	17.22%	79.58%
Sonneratia alba	48.39%	44.44%	65.89%	158.72%
Xylocarpus moluccensis	0.65%	2.78%	1.37%	4.80%

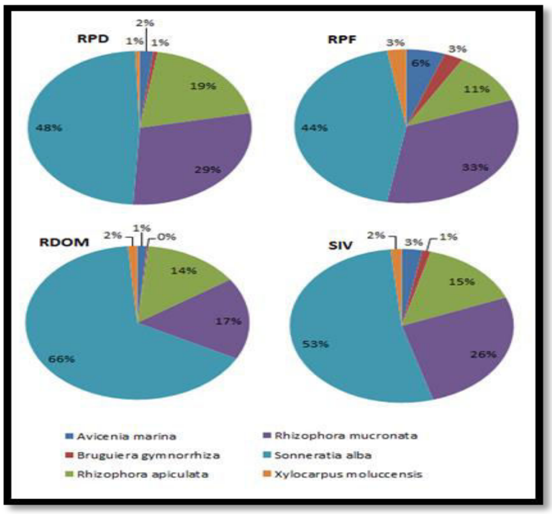

Figure-4. Chart percentage showing the vegetation values in Alabel, Sarangani Province.

ARPN Journal of Agricultural and Biological Science

Community structure

Cluster analysis in Figure-3 showed higher similarity among plots from the same site than plots from different sites. All the 21 sites in Alabel and 20 sites in Maasimwere clustered based on similarities and was divided into 3 groups with 40% similarity. The first group showed maximally similar plots having dominated in Alabel sampling area. Alabel sampling plots in cluster 1 were plots 13, 14, 17, 21, 10, 12, 4, 8, 5, 6 and 1 with plots 4, 1, and 11 in Maasim having the same attributes with the Alabel plots. The second group with similar plots dominates in Maasim having plots 6, 3, 8, 10, 18, 13, 9, 17 and 12 with plots 1, 11, 20, and 2 being moderately similarity in Alabel sampling plots. Lastly, the third group has almost equal number of sampling plots in both sites with Alabel having plots 7, 6, 8, 9, 13, 3, and 15 and plots 19, 7, 14, 16 and 20 in Maasim as the plots with very similar abundance attributes. It was derived that plot 3 in Alabel sampling site was a distinct plot and was considered as an outlier in the cluster analysis. Bray-Curtis similarity values were given as dendrogram in Figure-3.

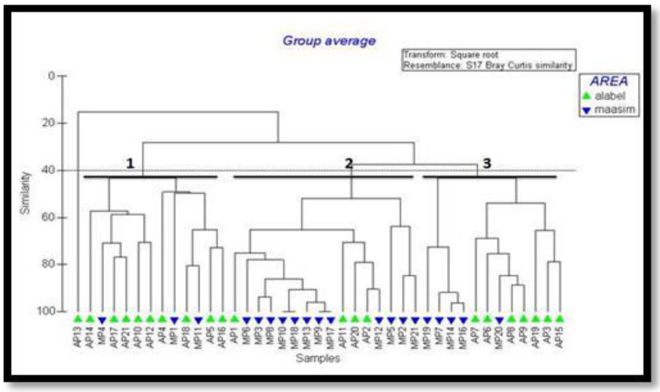

Figure-5. Cluster analysis showing the 3 groups formed at about 40% similarities in Alabel(▲ AP*n*) and Maasim (▼ MP*n*) sampling sites.

The nMDS ordination with a stress value of 0.13 basically indicated an acceptable ordination of the data. Two major groups formed the characteristics of the two sites. Group 1 as shown in Figure-3 has plots similarly dominant in terms of abundance in Alabel sampling site with fiveplots found to be similar in Maasim sampling site. Group 2 on the other hand has abundance characteristic similarly dominant in Maasim sampling plots but one plot from Alabel sampling site shows same characteristics respectively.

The ANOSIM value of (R=0.317, P=0.001) supported the similarity of the mangroves in the two sites. Mangroves in Alabel were not distinct but were showing plots with similar features to mangroves in Maasim. The same condition was also observed in Maasim showing similarity with mangroves in Alabel. The results depicted in cluster analysis and nMDS supports this observation.

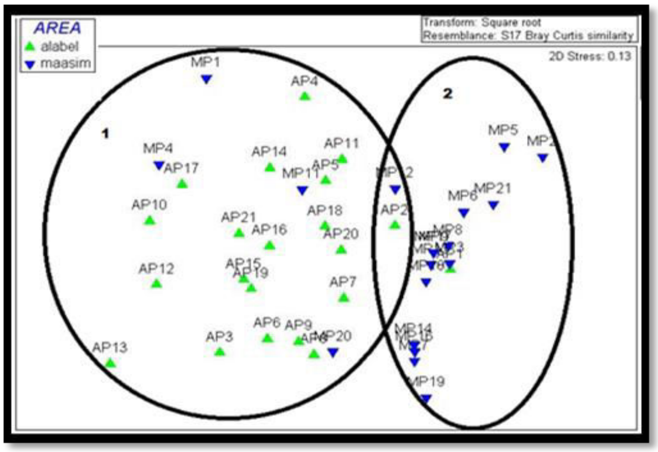

Figure-6. Multi-dimensional scaling (MDS) ordination for the two sampling sites in Alabel (▲ AP*n*) and Maasim (▼ MP*n*), Sarangani Province.

CONCLUSIONS AND RECOMMENDATIONS

Analysis in vegetation in Alabel showed that species with the highest importance value was *A. marina* (84.72%) followed by *S. alba* (76. 45%) and *R. apiculata* (61.32%).*S. alba* (158.72%), *R. mucronata* (79.58%) and *R. apiculata* (44.39%) were found to have the highest importance value in Maasim sampling site showing the dominance of these species in the vegetation of the mangrove forest. The mangrove community structure showed no distinct characteristics on the two sites. Some areas represented in the sampling plots were very much similar in structure in the two sites. It was supported in the analyses using cluster analysis, nMDS, and one way ANOSIM.

ACKNOWLEDGEMENT

The researchers would like to thank Ms. Mikaela Caryl Tanedo and Mr. Carl Nacin for assisting in the field work and Mindanao State University-General Santos City for supporting the study.

REFERENCES

[1] Primavera J. H. and Esteban J. M. A. A review of mangrove rehabilitation in the Philippines: successes, failures and future prospects. Wetlands Ecology and Management. 2008. 16(5) 345–358.

[2] Duke N.C. 1992. Mangrove Floristics and Biogeography. In Tropical Mangrove Ecosystems; Robertson, A.I., Alongi, D.M., Eds.; Coastal and Estuarine Geophysical Union. Washington, DC, USA.

[3] Kathiresan K. 2003. Ecology and environment of mangrove systems. In: K. Kathiresan and A.N. Subramanian (eds.). UNU – UNESCO International Training Course on Biodiversity in Mangrove Ecosystems, Course Manual. Annamalai University, India. pp. 62-90.

[4] Tomlinson P. B. 1986. The botany of mangroves. Cambridge University Press, Cambridge. 413 pages. ISBN 0-521-25567-8.

[5] Abeysinghe R.D., Greene B.T., Haynes Willingham R.M.C, Turner J., Planalp R.P., Brechbiel M.W., Torti., F.M. and Torti, S.V. 2001. Independent Apoptosis Mediated by Tachpyridine, an Anti-cancer Iron Chelator Carcinogenesis. pp. 1607–1614.

[6] Bonan G. B. 2008. Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests. 320(5882):1444–1449.

[7] Gillis J. 2011. With deaths of forests, a loss of key climate protectors. The New York Times.

[8] Moutinho P. and Schwartzman S. 2005. Tropical Deforestation and Climate Change. Amazon Institute for Environmental Research.

[9] Walsh, G.E. 1974.Mangroves: a review. In: Reinhold, R.J., Queen, W.H. (Eds.). Ecology of Halophytes. Academic Press, New York, USA. pp. 51–174.

[10] http://maps.google.com

[11] http://www.gpsvisualizer.com

[12] Odum E. P. andBarett, G. W. 2005. Fundamentals of Ecology. Fifth Edition. Brooks/Cole, a division of Thomson Learning Asia, 5 Shenton Way # 01.01 UIC Building, Singapore 068808.

[13] Cox G. W. 1996. Laboratory Manual of General Ecology, 7th Edition. WMC Brown Publishers Boston.

[14] Kent M and Coker P. 1992.Vegetation Description and Analysis: A Practical Approach. SRP Ltd. ExeterGreat Britain. pp. 167-169.

[15] Krebs C. J. 1985. Ecology: The Experimental Analysis of Distribution and Abundance. Third Edition. Harper and Row Publishers, Inc., 10 East 53d St. New York NY 10022. pp. 436-461.

[16] Mueller-Dombois D. and Ellenberg H.1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons Inc., New York, USA. pp. 67-135.

[17] Falcaro M and PicklesA. 2010. Riskplot: A graphical aid to investigate the effect of multiple categorical risk factors. Stata Journal. 10: 61–68.

[18] Cox T.F. and Cox M.A.A. 2001. Multidimensional Scaling. Chapman and Hall.

[19] Clarke KR. 1993. Non-parametric multivariate analyse of changes in community structure. Australian Journal of Ecology. 18: 117-143.

[20] Sinfuego K and Buot Jr I.E. 2008. Floristic composition and analysis of the true mangrove vegetation in the Philippine Islands. J. Nat. Stud. 7: 83–90.