MANAGED AND UNMANAGED MANGROVE FOREST IN LIANGA BAY, SURIGAO DEL SUR

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Abstract

The study on mangroves in managed and unmanaged mangrove forests in Lianga Bay was conducted to benchmark information on the mangrove species composition, diversity, density and resource utilization as well as the management initiatives for future policy formulation for sustainable management. Thirty (30) species of mangroves were identified in the managed mangrove forest. Rhizophora apiculata was found to be the most dominant species structuring the managed and unmanaged mangrove communities of Lianga Bay. The least species accounted were the Barringtonia racemosa, Camptostemon phillipinensis and Ceriops decandra. Nypa fruticans was among the variety of mangrove species utilized for production of shingles, vinegar, food, and native wine. Other noted resource utilization of the mangroves includes firewood, charcoal, fences, and poles were observed mostly in unmanaged mangrove forest of Lianga Bay. Management intervention in all the managed mangrove forests helped in the preservation and conservation advocacy of the national government being initiated by the Community-Based Resource Management Project (CBRMP) in collaboration with the Department of the Natural Resources, the academe, Non-government organization, Non-government agencies and the steward-beneficiaries in the barangays and municipalities.

Keywords: *mangroves, managed, unmanaged, mangrove forests, Lianga Bay*

1.0 Introduction

Lianga Bay and its resources are shared by the four municipalities, viz; Barobo, Lianga, Otieza (now San Agustin) and Marihatag all located at the center of the Province of Surigao del Sur. The Bay has been known for its diverse and abundant coastal resources. Identified to be rich coastal resources is the mangroves, seagrasses and corals. The mangroves resource of the bay provides socioeconomic benefits to the fisherfolks in the area. Molles (2005) cited that mangrove forests are extremely vulnerable to human interference. People want to live and work at the coast. Therefore, the increase in population and poverty have added pressure on the resources, subsequently resulting in increasing environmental damage, overfishing and alarming degradation of habitats. White, et al. (2006) added that coastal marine habitats are being exploited beyond their capacity to recover as overfishing and destruction of coral reef, mangrove, seagrass and estuarine habitats continue.

Mangrove forest has been considered very significant coastal resource because of the ecological and economic benefits that it has offered to humans and other mangrove dependent organisms (White, et al., 2006). Schatz (1991) as cited by Deguit, et al., (2004) presented that one (1) hectare of

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mangrove produces up to 3 tons of litterfall annually, and one (1) hectare of healthy mangrove ecosystem produces about 1.08 tons of fish per year. FSP-DENR (2001) added details for a hectare of fully developed mangrove plantation produce an annual fish yield of 100 kg of finfish, 25 kg of shrimps, 200 kg of mollusks, 40 kg of sea cucumber and 400 kg finfish and 57 kg of shrimps that mature elsewhere. Present experiences indicate that as the human population density increases, the quality of life and integrity of the environment correspondingly decreased for the average person living in the coastal areas (Deguit et al., 2004). Human impacts on the mangrove ecosystem of the bay are cutting of trees for firewood, posts, conversion of the area into fishpond and human settlement, boat docking and sewage.

Rapid increase in population and the traditional practices along mangrove resources are probably the key factors that contributed to the loss of biodiversity of the mangrove ecosystems. Mangrove forests faced remarkable damage due to anthropogenic interventions. Socioeconomic strains like the needs of the people for food, housing, recreational areas, improper waste disposal, cutting of trees and the natural stressors like big waves and winds, and siltation can be felt in nearshore residents.

The study of mangroves in managed and unmanaged forests are classified into (1) managed forests- this means programs and projects are implemented for conservation, protection and preservation management and (2) unmanaged mangrove forests are those that are left alone, no labor inputs, and no management initiatives. There is a need to benchmark information on mangrove species, distribution, density, abundance and diversity in the managed and unmanaged mangrove forests. Resource utilization as well as the management initiatives as related components on the biodiversity status of the ecosystem were also determined. Generated data can be used for future reference in crafting policies to strengthen the implementation of the programs and projects for sustainable management.

2.0 Research Methodology

The study was conducted in the managed and unmanaged mangrove forests of the four municipalities of Lianga Bay, Surigao del Sur. These include Barobo, Lianga, Otieza - now San Agustin and Marihatag (fig. 1). Lianga Bay is located on the east coast in the Province of Surigao del Sur, in the Caraga Region, or Region XIII, Mindanao. Facing the Pacific Ocean, it has a total area of 49,390.7 has. Overall, the Lianga Bay municipalities occupy a total land area of 1,007.50 km^2. Table 1 shows the land area, number of barangays, and length of coastline for each municipality comprising the Lianga Bay cluster. There are 36 coastal barangays with a total coastline length of 184.27 km.

Descriptive type of research is used in this study. The indices of species diversity were calculated using descriptive statistics. Interview with the local folks were conducted to generate first hand information as to the degree the mangrove resources have been utilized and conserved.

This study used a transect line method to assess the forests on site. Transect lines were established per sampling stations with considerations on the different parameters investigated of the mangrove forest (e.g. with or without communities, open or protected, near or far from rivers) using resource map or other available map of the sampling stations.

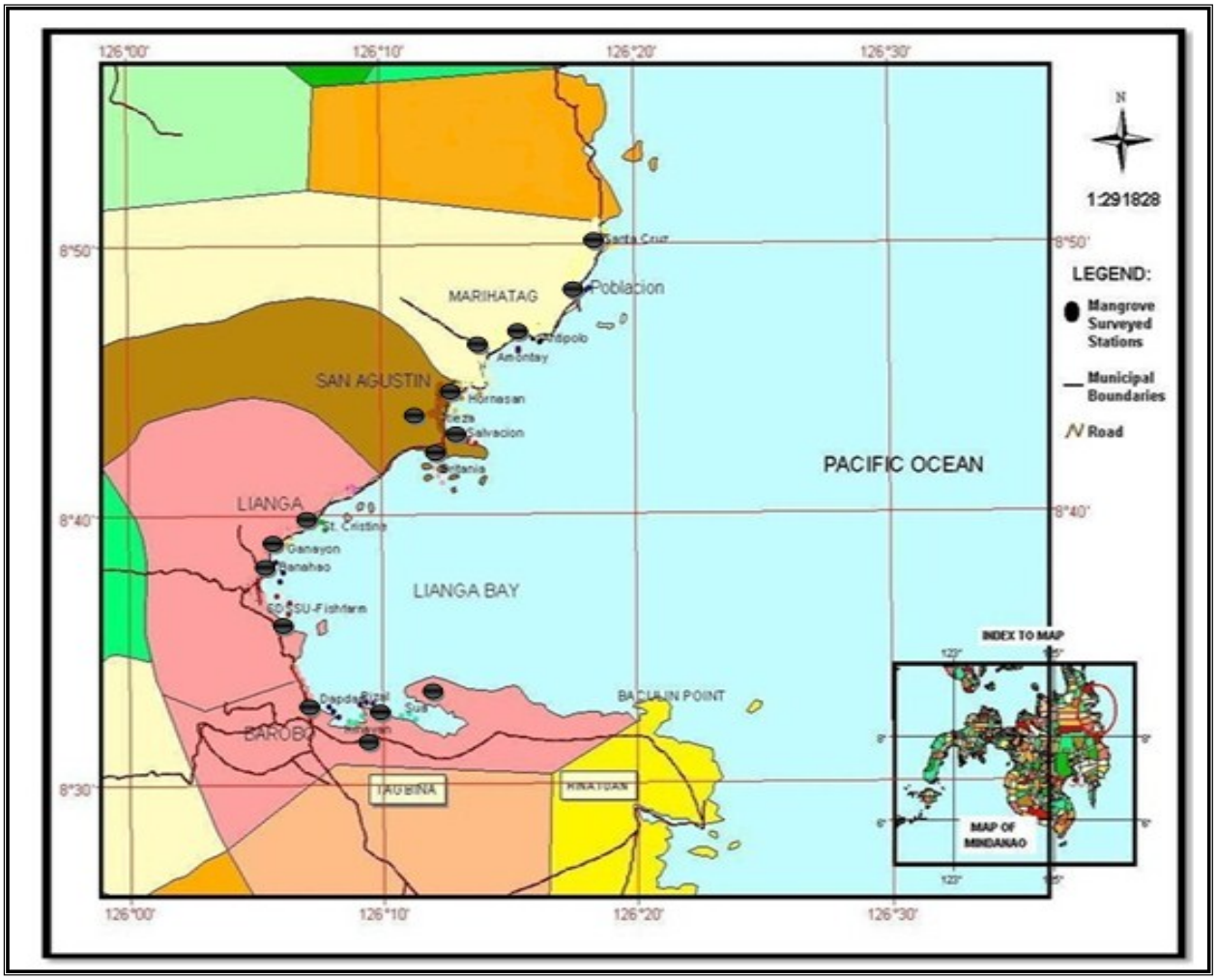

Figure 1. Map showing the four municipalities of Lianga Bay and its sampling stations

Table 1. The physical characteristics of the coastal municipalities of Lianga Bay

Municipality	Land Area (sq.km)	Number of Barangays	Number of Coastal Brgy.	Coastline Length (km)
1. Marihatag-	342.50	12	7	14.75
2. San Agustin*	255.00	13	10	86.38
3. Lianga-	253.30	13	10	29.64
4. Barobo -	156.70	22	9	53.5
TOTAL	1,007.50	60	36	184.27

** with two barangays unmanaged mangrove forests*
- all managed mangrove forests

Transect lines for each site were established by laying down the 100m rope for every selected transect position. For every transect line established, plots were established randomly along the transect line if the zone is wide or at the sides of the transect line if the zone is narrow. The sides of the plot used 10m x 10m rope. For each of the species in the plot, the total number of mature trees were counted and recorded. The circumference of all mature trees were measured and recorded (at breast height, approximately 1.3m from the ground). In stations where growth of mangroves were irregular, standard procedure using English et al., (1994) was employed in measuring the circumference at breast height (CBH) and was followed all throughout the sampling.

2.1 Mangrove Community Structure Analysis

The abundance, density, frequency, basal area, and dominance and importance value for each species were determined using the following formula of the IIRR (1998) and English, et al., (1994).

2.2 Mangrove Resource Utilization and Management Initiatives

According to Macintosh and Ashton (2002), the mangrove ecosystem has important direct and indirect economic, ecological and social values to man. Mangrove ecosystems have consistently been undervalued, usually because only their direct goods and services have been included in economic calculations.

Data on the mangrove resource utilization was generated through an interview with the local people, the officers and members of the Peoples' Organization and the actual observations from the field with proper documentation on the activities. Management initiatives were also generated by gathering secondary data from the Peoples' Organization, Barangay Council, Local Government Unit and the Department of Environment and Natural Resources Office including the Non-Government Organization involved.

3.0 Results and Discussion

3.1 Composition of Mangrove Species in Lianga Bay, Surigao del Sur

There were 30 species of mangroves identified belonging to 15 families. Table 2 reflects mangrove species in managed and unmanaged areas of Lianga Bay. A total of 30 species were noted in the managed areas, namely: *Acanthus ebracteatus, Acanthus ilicifolius L., Acrosticum aureum, Avicennia alba* Blume, *Avicennia officinalis* L, *Avicennia marina* (Forsk) Vien, *Camptostemon phillipinensis* (Vidal) Becc., *Lumnitzera littorea* (Jack) Voigt., *Lumnitzera racemosa* Wild., *Excoecaria agallocha* L., *Xylocarpus granatum* Koen, *Aegiceras corniculatum* (L. Blanco), *Aegiceras floridum* Roem and Shult , *Nypa fruticans* (Thumb.) Wumb. *Bruguiera cylindrica* (L) Blume , *Bruguiera gymnorrhiza* (L.) Lam, *Bruguiera parviflora* Wight and Arn. ex. Griff, *Bruguiera sexangula* (Lour.) Poir, *Ceriops decandra* (Griff.) Ding Huo, *Ceriops tagal* (Per C.B Rob), *Rhizophora apiculata* Blume, *Rhizophora mucronata* Lam, *Rhizophora stylosa* Griff., *Sonneratia alba* J. Smith, *Sonneratia caseolaris* J. Smith (L.) Engl, *Barringtonia racemosa, Dolichandron spathacea, Calophylum inophylum, Heritiera littoralis* Dryand. ex. w. Alt and *Barringtonia asiatica* .

In the unmanaged mangrove forests of the bay, 16 species were noted, namely:

A. ebracteatus, Acanthus, A. aureum, A. alba, A. officinalis, A. marina, A. officinalis, B. racemosa, B. gymnorrhiza , B. parviflora, L. Littorea L. racemosa, R. apiculata, S. alba, S. caseolaris X. granatum. Of the 30 identified species, only *B. racemosa* was not found in the managed area. This could mean that an introduced species happened to adopt in the unmanaged forest areas. It is in this place where a rare species of *Avicennia* species was found, the *A. alba.*

Table 2. Mangrove species in managed and unmanaged mangrove forests across sampling stations.

	MANAGED															UNMANAGED
SPECIES	Sua	Rizal	Kinayan	Dapdap	SDSSU	^Banahao	Ganayon	St.Christine	Britania	Oteiza	Amontay	Antipolo	Poblacion	Sta. Cruz	Salvacion	Hornasan
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16
Acanthus aureum	●			●	●	●	●	●			●		●		●	●
Acanthus illicofolius	●			●	●	●	●	●			●		●		●	●
Acanthus ebracteatus													●			●
Aegiceras corniculatum		▮	▮	▮	▮			▮			▮		▮	▮		▮
Aegiceras floridum							▮									▮
Avicennia alba													▮			
Avicennia marina					▮						▮		▮	▮	▮	▮
Avicennia officinalis									▮		▮		▮	▮		▮
Barringtonia racemosa																▮
Bruguiera cylindrica						▮						▮				
Bruguiera gymnorrhiza	▮	▮	▮	▮	▮	▮	▮	▮	▮		▮	▮	▮			▮
Bruguiera parviflora			▮		●	▮	▮					▮	▮			▮
Bruguiera sexangula					▮	●		▮	▮		▮	▮				
Camptostemon philippinensis						▮	▮		▮							
Ceriops decandra	▮					▮										
Ceriops tagal						▮						▮				
Excoecaria agallocha										▮						
Heritiera littoralis													▮			
Lumnitzera littorea					●	▮	●	▮	▮			▮				▮
Lumnitzera racemosa						▮	●				▮	▮				▮
Nypa fruticans	●				●	●	●	▮			▮	●	●	▮		
Rhizophora apiculata	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮
Rhizophora mucronata												●	●			
Rhizophora stylosa			▮	▮			▮		▮	▮			▮			
Scyphiphora hydrophylacea						●	●					●				
Sonneratia alba	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	●		▮	▮	▮
Sonneratia caseolaris						●						▮				▮
Calophylum inophylum L.													▮			
Xylocarous granatum	▮	▮			▮		▮	▮	▮		▮	▮	▮			▮
Delichandrone spathacea.												●	●			
TOTAL No. of Species:	8	5	6	7	12	16	14	10	9	4	12	15	17	6	5	16

3.2 Community structure of the managed and unmanaged mangrove forests in Lianga Bay, Surigao del Sur.

Three parameters were considered namely: frequency, density and abundance of mangroves as presented in Table 3. For relative frequency, *R. apiculata* with an index of 33.82% ranked the highest for the managed as well as in the unmanaged areas with 28.93%. *E. agallocha* was observed the least (1.39%) for the managed, the *X. granatum* obtained the least with 0.97% for unmanaged. The abundance and domination of *Rhizophora* may be probably due to the muddy substrate in the site which is favorable for its growth (Hogarth 1999).

N. fruticans has a different characteristic compared to that of the other species, in the sense that this species is not considered a tree, but a palm, the only plant in *Palmae* family as true mangrove species. The managed and unmanaged areas scored a total mean value of 47.18 and 2.00. Both the average number of plants and the average number of fronds show no significant difference in the population of both the managed and unmanaged mangrove forests of Lianga Bay.

Nipa products prominently provide shingles for roofing and sap for native wine and vinegar and are abundantly available in Barangay Poblacion of Marihatag. Wood products gatherings were observed however, it is very minimal. With the Community-Based Resource Management Project (CBRMP) in collaboration with the local government unit, academe NGOs, NGAs and the beneficiaries settled down for common understanding of proper stewardship.

According to IUCN Red list of threatened species (2010), the *Aegiceras floridum* and *Ceriops decandra* were in the status of threatened species worldwide. However, in Lianga Bay *A. floridum* had a second highest rank in terms of relative frequency of 30.65% in managed forest and in unmanaged of 6.8%. In *C. decandra* in terms of relative frequency, density and abundance of 1.58, 0.44, 0.44 respectively in managed forest. There is no *C. decandra* in unmanaged forest.

In the managed mangrove forests of the bay, project implementations were initiated mostly by the Local Government Unit via the Community Based Resource Management Projects (CBRMP). There are also Non-Government Organizations initiating the same moves. Peoples' Organization (PO) as beneficiaries and trusted group was covered by the Memorandum of Understanding (MOA)/Agreement or by laws which served as guide in the management operation of the project.

Some quantitative measurements giving valuable information on the species can become useful in understanding the composition and structure of the managed and unmanaged mangrove forests of Lianga Bay as presented in table 4.

Managed mangrove forest has the highest average CBH (1,234.00), average basal area (852,435.90), and averages stems/ha (337.8) compared to unmanaged forest of CBH (843.4), average basal area (216,261.80), and averages stems/ ha (228.5). This is due to the utilization of large mangrove into economic purposes such as woods, charcoals and other uses. Among managed mangrove species, *R. apiculata* has the highest basal area (14,576,075.60) followed by *X. granatum* (3,292,589.60) (Table 4). *Rhizophora apiculata* has the highest stems/ha (2,918.00) followed by *A. floridum* (1,781.50). The other species of mangrove were rather inconspicuous in terms of basal area and stem number.

Table 3. Frequency, density and abundance of mangrove in managed and unmanaged forest

Family	Species	IUCN Red List	Relative Frequency		Relative Density		Relative Abundance	
			Managed	Unmanaged	Managed	Unmanaged	Managed	Unmanaged
Acanthaceae	*Acanthus aureum*	Not yet Assessed	9.8	-	6.02	-	1.97	
	Acanthus ebracteatus Vahl	Least Concern	-	-	-	-	-	-
	Acanthus illicifolius L.	Least Concern	10.38	14.56	11.17	15.57	2.59	12.14
Aviceanniaceae	*Avicennia alba* Blume	Least Concern	9.8	-	6.02	-	-	-
	Avicennia marina (Forsk.) Vierh	Least Concern	8.96	25.48	2.58	22.54	0.45	15.37
	Avicennia officinalis L.	Least Concern	9.31	11.65	1.57	14.58	18.42	9.24
Bignoniaceae	*Delichandrone spathacea*	Least Concern	-	-	-	-	-	-
Bombaceae	*Camptostemon philippinensis* (Vidal) Becc	Endemic	-	-	-	-	13.3	-
Combretaceae	*Lumnitzera littorea* (Jack) Voigt.	Least Concern	3.92	1.94	1.34	1.35	0.16	-
	Lumnitzera racemosa Wild.	Least Concern	2.99	1.94	1.96	2.52	0.24	0.16
Euphorpbiaceae	*Excoecaria agallocha* L.	Least Concern	1.39	-	0.07	-	0.01	-
Guttiferae	*Calophylum inophylum* L.	Least Concern	-	-	-	0.64	24.37	0.03
Lecythidaceae	*Barringtonia racemosa*	Least Concern	-	1.94	-	0.18		0.18
Meliaceae	*Xylocarous granatum* Koen.	Least Concern	8.64	-	11.99	-	-	-
Myrsinaceae	*Aegiceras corniculatum* (L.) Blanco	Least Concern	10.38	14.56	11.17	15.57	2.59	12.14
	Aegiceras floridum Roem	Near Threatened	30.65	6.8	30.79	8.37	2.02	2.18
Palmae	*Nypa fruticans* (Thunb.)Wurmb.	Least Concern	7.05		2.01	-	0.01	-
Rhizophoraceae	*Bruguiera cylindrica* (L.) Blume	Least Concern	3.3	-	0.49	-	0.01	-
	Bruguiera gymnorrhiza (L.)Lam	Not yet Assessed	19.89	5.83	6.64	2.25	2.12	0.4
	Bruguiera parviflora Wight and Am.	Least Concern	3.29	1.94	0.69	0.54	0.01	0.03
	Bruguiera sexangula (Lour.) Poir.	Least Concern	7.26	-	1.65	-	0.32	-
	Ceriops decandra (Griff.) Ding Hou	Near Threatened	1.58	-	0.44	-	0.04	-
	Ceriops tagal (Perr) C.B. Rob	Least Concern	3.3	-	0.57	-	0.04	-
	Rhizophora apiculata Blume	Least Concern	33.82	28.95	65.91	46.76	68.36	66.26
	Rhizophora mucronata Lam	Least Concern		-	-	-		-
	Rhizophora stylosa Griff.	Least Concern	15.22	-	6.53	-	1.44	-
Rubiaceae	*Scyphiphora hydrophyllacea* Gaertn.	Least Concern	-	-	-	-	-	-
Sonneratiaceae	*Sonneratia alba* J. Smith	Least Concern	13.34	19.86	3.11	5.14	3.88	5.14
	Sonneratia caseolaris (L.) Engl.	Least Concern	2.17	3.88	0.9	5.13	0.01	2.09
Sterculiaceae	*Heritiera littoralis* Dryand.ex W. Ait.	Least Concern	13.73	-	1.2	-	0.68	-

Table 4. Community structure of managed and unmanaged mangrove forests in Lianga Bay, Surigao del Sur

SPECIES	Managed				Unmanaged			
	Ave. # of trees	*Ave. CBH*	*Ave. Basal Area*	*Ave. stems/ha.*	*Ave. # of trees*	*Ave. CBH*	*Ave. Basal Area*	*Ave. stems/ha.*
Aegiceras corniculatum (L.) Blanco	99.1	965.3	124,279.20	367.1	173	2,132.00	361,712.50	640.7
Aegiceras floridum Roem	481	1,156.50	106,434.00	1,781.50	93	904	65,031.80	344.4
Avicennia alba	15	454	16,402.20	55.6	217.5	2,780.00	623,204.80	805.6
Avicennia marina (Forsk.) Vierh	12.8	230.5	7,231.00	47.2	-	-	-	-
Avicennia officinalis L.	15.5	947.5	162,149,10	57.4	162	1,860.00	275,305.60	600
Barringtonia racemosa	-	-	-	-	2	257	5,256.00	7.4
Bruguiera cylindrica (L.) Blume	7	78	645.3	25.9	-	-	-	-
Bruguiera gymnorrhiza (L.)Lam	90.9	1,574.60	258,963.20	336.7	25	385	11,795	92.6
Bruguiera parviflora Wight and Am.	113.4	2,600.10	421,757.60	420.1	6	98	764.3	22.2
Bruguiera sexangula (Lour.) Poir.	26.8	523.3	38,978.80	99.1	25.4	485.6	32,969.20	94.1
Camptostemon philippinensis (Vidal) Becc	86.7	2,906.00	1,106,176.00	321	-	-	-	-
Ceriops tagal (Perr) C.B. Rob	7.5	159	3,157.70	27.8	-	-	-	-
Ceriops decandra (Griff.) Ding Hou	5.5	186	3,715.90	20.4	-	-	-	
Delichandrone spathacea	1	98	764.3	3.7				
Excoecaria agallocha L.	1	48	183.3	3.7	-	-	-	-
Heritiera littoralis Dryand.ex W. Ait.	3	267	5,673.00	11.1	-	-	-	-
Lumnitzera littorea (Jack) Voigt.	17.8	265.8	15,695.50	65.7	15	118	1,108.00	55.6
Lumnitzera racemosa Wild.	23.7	377	24,469.80	87.7	28	245	4,776.60	103.7
Nypa fruticans (Thunb.)Wurmb	24.7	92.7	820.8	91.4				
Rhizophora apiculata Blume	787.9	11,773.40	14,576,075.60	2,918.00	433	5,850.00	2,889,493.00	1,603.70
Rhizophora mucronata Lam	86.2	561.8	64,469.60	319.1				
Sonneratia alba J. Smith	40.1	1,175.20	225,841.50	148.5	51.5	1,604.50	206,966.70	190.7
Sonneratia caseolaris (L.) Engl	20	157	1,961.50	74.1	57	884	62,186.10	211.1
Xylocarous granatum Koen	222.8	3,018.20	3,292,589.60	825.1	7	108	928.2	25.9
AVERAGE:	91.2	1,234.00	852,435.90	337.8	61.7	843.4	216,261.80	228.5

3.3 Comparison of species assemblages between sampling stations

The comparison of mangrove species assemblages across the sampling stations of the Municipalities in Lianga Bay is presented using Bray-Curtis similarity indices computed from the mean quantitative measurements. Short distances indicate large similarity. Longer nodes indicate larger differences between sampling stations. In the dendogram shown on fig. 2, Dapdap and SDSSU are the most similar and join to form the first cluster, followed by Rizal and Sta. Cruz; Britania and Kinayan; St. Christine and Antipolo respectively. Also there are join pairwise clusters, such as the joining of station Sua in the first cluster of Dapdap and SDSSU. Alternatively, there are stations that are sequentially added to an existing cluster, such as the join of Oteiza in the cluster of Britania and Kinayan. This cluster analysis implied that mangrove assemblage in different sampling stations shared same species across sampling stations.

The results of this study are very alarming in unmanaged mangrove forest. Present experiences indicate that as the human population density increases, the quality of life and integrity of the environment correspondingly decreases for the average person living in the coastal areas (Deguit, et al., 2004).

Human impacts on the mangrove ecosystem of the bay are cutting of trees for

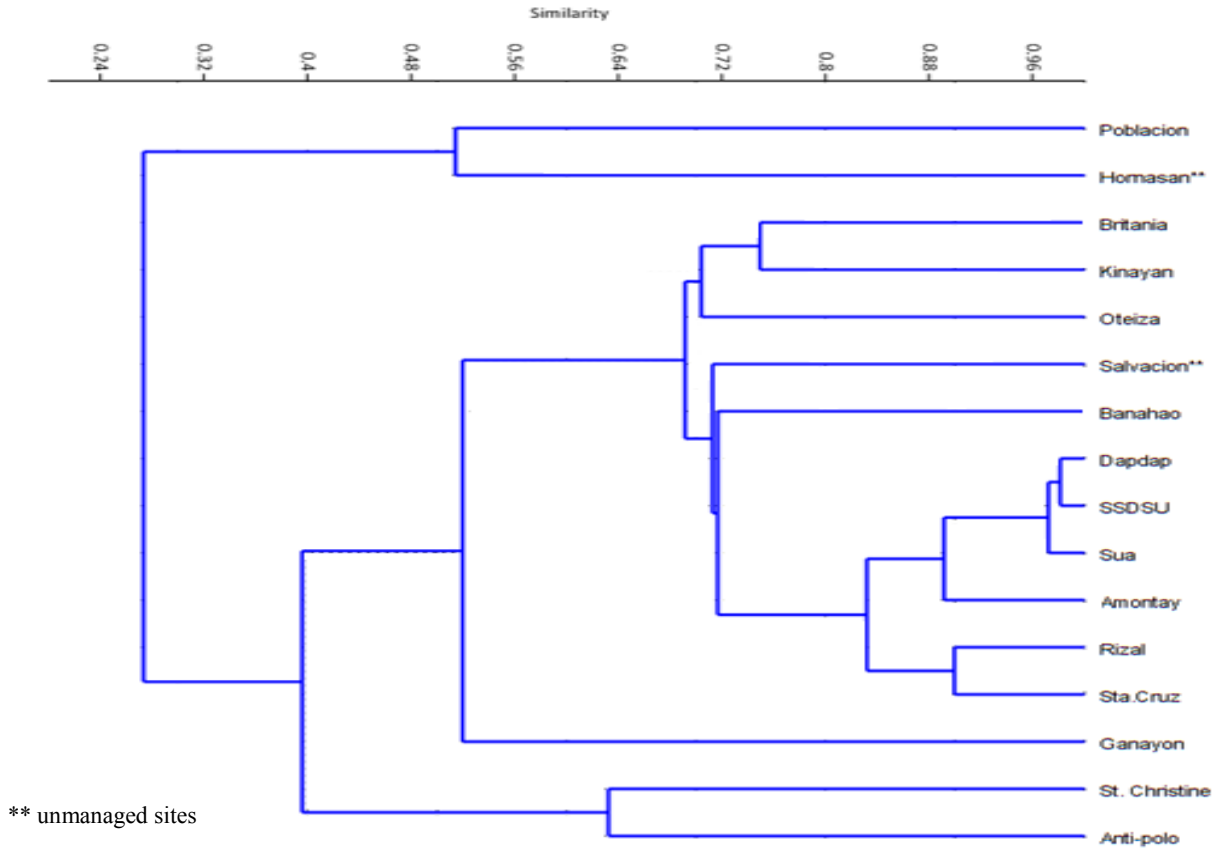

Figure 2. Comparison of mangroves assemblages between sampling sites in Lianga Bay using Bray-Curtis similarity indices computed from the mean quantitative measurements, short distances indicate large similarity.

firewood, posts, conversion of the area into fishpond and human settlement, boat docking and sewage. Also, Molles (2005) added that mangrove forests are extremely vulnerable to human interference. People want to live and work at the coast. Therefore, the increase in population and poverty have added pressure on the resources, subsequently resulting in increasing environmental damage, overfishing and alarming degradation of habitats. White et al., (2006) added that coastal marine habitats are being exploited beyond their capacity to recover as overfishing and destruction of coral reef, mangrove, seagrasses and estuarine habitats continue.

4.0 Conclusion

The study revealed that most of the projects implemented in the mangrove ecosystem gained its reward of success. People learned the value of conserving and protecting the resource. In some parts of the bay, people are vigilant on the negative interventions towards the mangrove forest. The Peoples Organizations topped to lead and are covered with the Memorandum of Understanding serving their guide for the managerial operation of the mangrove resource. Generally, implementations of the projects were successfully attained to consider the impressive growth of mangrove trees in the rehabilitated forests and the economically important marine species seen increasing.

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