Community-based Biophysical Monitoring of Mangroves in Lawaan, Eastern Samar

Southeast Samar PO Consortium and Guiuan Development Foundation, Inc.

This study provided baseline mangrove information for the Municipality of Lawaan, Eastern Samar. The study was conducted through a community-based initiative and aimed to inspire other people's organizations (POs) or local communities to pursue their own biophysical monitoring. This grassroot effort can make a bigger impact on understanding the dynamics of mangrove forests. The presentation highlighted the diversity of mangroves in Lawaan, the importance of mangroves to the community, the community's effort to protect and manage mangroves, and the importance of community-academe partnership.

I. Introduction

An estimated 275.6 ha of fringing mangroves and about 136.9 ha of coral reef lie within the 31.97 km shoreline of Lawaan, Eastern Samar. Majority of the residents in Lawaan live in coastal areas and rely mostly on fishing and gleaning on mangrove areas and seagrass beds as their primary source of income and food. In November 2013, Lawaan was one of the areas directly affected during the onslaught of Super Typhoon (ST) Yolanda (international name: Haiyan). Out of the 14 municipalities evaluated for post-Haiyan impact assessment, the mangrove forests in Eastern Samar, including Lawaan, sustained partial to minimal damage to none (Primavera 2014).

Mangrove forests support a variety of life and serve as a nursery habitat particularly for commercially important fish and invertebrate species. These ecosystems also serve as natural buffers against waves and help prevent shoreline erosion. However, the mangrove stands in Lawaan suffer damages both from natural hazards and from anthropogenic activities. Apart from the damages sustained from frequent weather disturbances, local anecdotes revealed that uncontrolled destructive livelihood activities (such as tree cutting for commercial

and domestic use by residents) continue to damage the mangroves. Local POs, such as the Southeast Samar PO Consortium (SeaSPOC), in cooperation with the local government unit of Lawaan and NGOs, conduct monitoring activities and implement rehabilitation projects. These projects are funded by private entities and/or government projects. Despite the concerted efforts, abuses on the use of mangrove resources are still observed in the area. Some offenders come from the neighboring towns but particularly from Marabut, Samar. It is necessary to create an integrated and localized governance mechanism that would ensure effective and meaningful participation of local stakeholders in developing and implementing mangrove conservation measures.

This study updated the information on the status of mangrove forests that can be used by government agencies and other stakeholders. This study determined the extent of mangrove cover as well as the distribution, abundance, and diversity of mangrove species in Lawaan. Problems and issues concerning mangrove rehabilitation were also described.

II. Materials and methods

Site description

Seventeen representative sampling stations were established within the mangrove patches in Lawaan: Bolusao (1), Guinob-an (1), Betaog (5), Poblacion (2), Taguite (5), and Maslog (3). A handheld global positioning system (GPS) unit was used to record the coordinates of each sampling station.

Mangrove cover

Two teams conducted a perimeter survey to determine the extent of the mangrove cover on November 3 to 5 and November 16 to 18, 2016. Each group used a handheld GPS unit to mark the points lining the periphery of the mangroves. One group was assigned to mark the coordinates of the perimeter of the mangroves on the landward border, while the other group was tasked to delineate the boundary between the mangrove and seagrass beds. The coordinates were plotted to create a map and estimate the mangrove area.

Composition, abundance, distribution, and diversity

A rapid mangrove biophysical assessment was conducted on September 1 to 16, 2017. The team laid out a 100 m transect perpendicular to the shoreline, across the mangrove band. Representative 10 x 10 m sampling plots were established spanning the landward, middle, and seaward areas of the mangroves. Mangroves were characterized per plot to account the number and type of mature trees (> 1 m in height and > 4 cm in diameter); saplings (>1 m in height and < 4 cm in diameter); and seedlings (< 1 m in height and < 4 cm in diameter). Measuring tapes were used to measure the diameter-at-breast height (dbh; cm) of all mature trees within the sampling plots. Mangrove species and mangrove-associated species were identified using Primavera (2009). The substrate type, as well as the anthropogenic impacts affecting the mangroves, were also described.

Data processing and analyses

The % abundance for each species was computed using the formula:

$$\%\ Abundance = \frac{N}{N_{Total}} X\ 100$$

Where:

N = number of mature trees for each species
N_{Total}= total number of mature trees for all species

The species diversity is the abundance in number of species in a given location and was computed using the Shannon-Weiner Index formula:

$$H = \sum_{i=1}^{S} (\frac{n_i}{n}) \ln (\frac{n_i}{n})$$

Shannon equitability (evenness)

$$E_H = \frac{H}{H_{max}} = H/lnS$$

Where:

H= diversity index
E_H = equitability (evenness)
S = total number of species (richness)
n_i = total number of individual for each species
n = total number of individuals for all species

The index of similarity for all the sites was computed using the Sorensen similarity coefficient formula as shown below:

$$S_s = \frac{2a}{2a + b + c}\ x\ 100$$

Where:

a = the number of species common to both communities/quadrats
b = the number of species unique to the first community/quadrat
c = the number of species unique to the second community/quadrat

The tree density, frequency, and dominance were computed based on the equations below:

Density

$$Stand\ density\ per\ ha = \frac{Total\ number\ of\ stem\ per\ site\ x\ 10{,}000}{Area\ of\ the\ plot}$$

$$Relative\ Density = \frac{No.\ of\ individuals\ of\ a\ species}{Total\ no.\ of\ individuals\ of\ all\ species}\ x\ 100$$

Frequency

$$Frequency = \frac{No.of\ plots\ of\ which\ a\ species\ occur}{Total\ no.of\ plots\ sampled}\ x\ 100$$

$$Relative\ frequency = \frac{Frequency\ value\ for\ a\ species}{Total\ frequency\ value\ for\ all\ spcecies}\ x\ 100$$

Dominance

$$Basal\ area\ (cm^2) = \frac{\pi\ (diameter\ at\ breast\ height)^2}{4}$$

$$Relative\ Dominance = \frac{Total\ basal\ area\ of\ a\ species}{Basal\ area\ of\ all\ species}\ x\ 100$$

Importance Value Index

$$Importance\ value = Relative\ Density + Relative\ frequency + Relative\ Dominance$$

III. Results and Discussion

Based on the perimeter survey, the municipality of Lawaan has 324.28 ha of mangrove forest (**Fig. 1**). Maslog (144.49 ha) has the highest mangrove area followed by Taguite (119.13 ha), Betaog (45.26 ha), and Bolusao (16.34 ha). Poblacion (9.08 ha) has the least mangrove patch. In a study in 2002, the combined extent of mangrove cover in the barangays of Betaog, Taguite, and Bolusao was 227.4 ha (Resource and Ecological Assessment of Mangroves of Lawaan, Eastern Samar). In a span of 15 years, the mangrove cover was reduced by 21 %.

Both natural and anthropogenic factors may have contributed to the reduction of mangroves in Lawaan. In November 2013, ST Yolanda heavily damaged the mangrove areas in Eastern Samar. Some anthropogenic activities that caused damage to the mangroves were the result of dire conditions that follow natural calamities. At around two to four months after the super typhoon, the mangrove trees in Eastern Visayas were observed recovering (Primavera et al. 2016). Left with few alternatives, some residents cut the defoliated mangroves, mistaken as dead, and used it in rehabilitating their houses. There were also clearing operations done by the locals.

On the other hand, the Ecosystems Research and Development Bureau (ERDB) stated that mangroves in Yolanda-affected areas in Eastern Samar failed to grow back its foliage six months after the typhoon. This is an indication that the trees had died even if their roots were still attached to the ground. Further, this condition was observed specifically among *Rhizophora* species. Aside from defoliation, the roots had grown fungi indicating rotting. The extent of damage was estimated at two to three times higher than the initial damage estimates in Eastern Visayas (Cinco 2014).

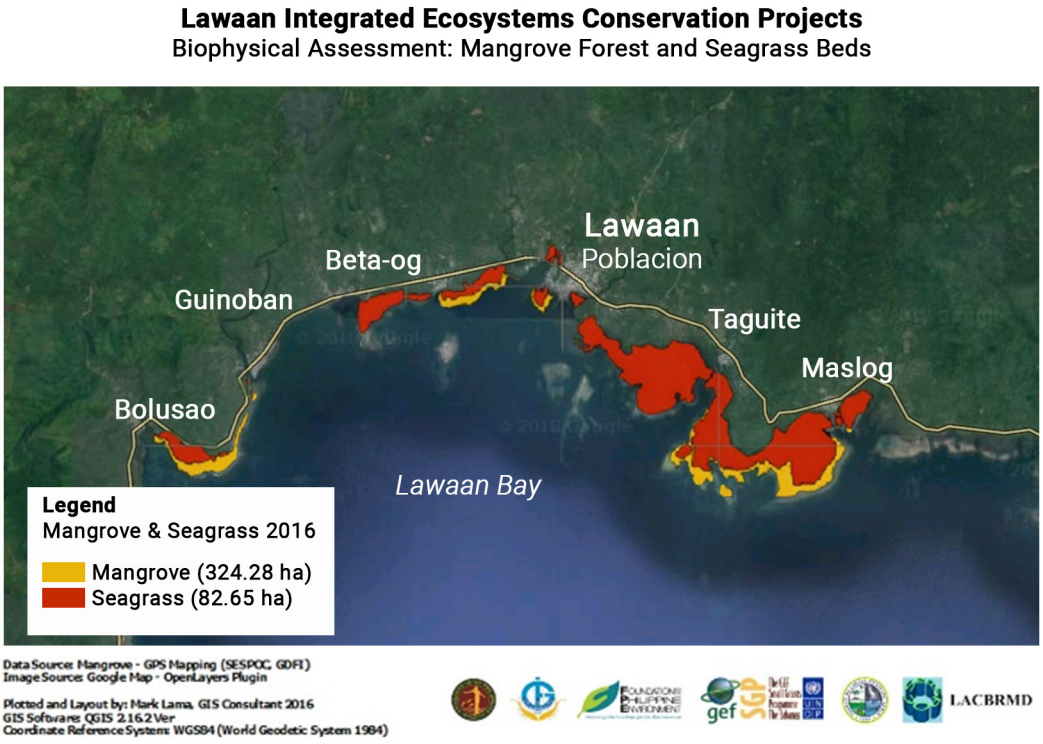

Figure 1. Extent of mangrove cover in Lawaan, Eastern Samar.

Species Composition and Abundance

Table 1 shows the species composition, distribution, and abundance of mangrove species in the coastal barangays of Lawaan. Twenty-one mangrove species were recorded: eighteen was described at species level, while three were only identified up to genus level. Betaog had the highest species richness (15), while Bolusao had the least species (7). The three most common mangrove species were *Sonneratia alba, Rhizophora apiculata,* and *Xylocarpus granatum.* The species *Avicennia rumphiana* was observed only in Maslog. *Nypa fruticans* was present in all coastal barangays in Lawaan.

The species *X. granatum* was the most abundant species (26.1 %), while *Aegiceras floridum* (1.3 %) and *Lumnitzera* sp. 1 (1.3 %) have the lowest abundance

Table 1. Species composition, average distribution, and abundance (%) of mangrove species in Lawaan, Eastern Samar as of September 2017.

Species	Bolusao		Guinob-an		Betaog		Poblacion		Taguite		Maslog	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
S. alba	5	21.7	6	18.8	3	6.9	8	12.7	7.4	22.7	5.7	12.5
R. apiculata	2	8.7	6	18.8	1.5	3.4	17	27	3.2	9.8	16	35
X. granatum	6	26.1	4	12.5	3	6.9	5.5	8.7	4	12.3	15	32.8
R. mucronata	-	-	6	18.8	20.5	47.1	15.5	24.6	10	30.7	1	2.2
E. agallocha	5	21.7	1	3.1	0.5	1.1	0.5	0.8	0.4	1.2	-	-
Avicennia sp. 1	-	-	4	12.5	0.5	1.1	3.5	5.6	-	-	-	-
A. floridum	1	4.3	-	-	6	13.8	3.5	5.6	2.6	8	-	-
B. gymnorrhiza	3	13	-	-	0.5	1.1	1	1.6	2.6	8	3	6.6
Lumnitzera sp. 1	1	4.3	-	-	0.5	1.1	5.5	8.7	-	-	-	-
C. tagal	-	-	2	6.3	1.5	3.4	0.5	0.8	0.4	1.2	0.33	0.7
C. decandra	-	-	-	-	2	4.6	2	3.2	-	-	0.67	1.5
S. hydrophyllacea	-	-	1	3.1	0.5	1.1	-	-	0.2	0.6	-	-
C. philippinense	-	-	-	-	2	4.6	-	-	0.6	1.8	-	-
Bruguiera sp. 1	-	-	2	6.3	-	-	-	-	-	-	-	-
A. rumphiana	-	-	-	-	-	-	-	-	-	-	0.67	1.5
O. octodonta	-	-	-	-	-	-	-	-	-	-	2	4.4
L. littorea	-	-	-	-	1	2.3	-	-	0.2	0.6	-	-
R. stylosa	-	-	-	-	0.5	1.1	0.5	0.8	-	-	-	-
H. littoralis	-	-	-	-	-	-	-	-	0.4	1.2	0.33	0.7
B. sexangula	-	-	-	-	-	-	-	-	0.4	1.2	0.33	0.7
L. racemosa	-	-	-	-	-	-	-	-	0.2	0.6	0.67	1.5
Total count	**23**	**100**	**32**	**100**	**43.5**	**100**	**63**	**100**	**32.6**	**100**	**45.7**	**100**
Total species	**7**		**9**		**15**		**12**		**14**		**12**	

in Bolusao. In Guinob-an, the species consist mostly of *S. alba* (18.8 %), *R. apiculata* (18.8 %), and *R. mucronata* (18.8 %). Majority of the species recorded in Betaog include *R. mucronata* (47.1 %), while *Excoecaria agallocha* (1.1 %), *Avicennia* sp. 1 (1.1 %), and *R. stylosa* (1.1 %) have the least abundance. In Poblacion, *R. apiculata* (27.0 %) was the most abundant and *E. agallocha* (0.8 %) and *Ceriops tagal* (0.8 %) were least abundant. Most of the species in Taguite were *R. mucronata* (30.7 %) with some *Scyphiphora hydrophyllacea* (0.6 %) and *Lumnitzera littorea* (0.6 %). Majority of the species recorded in Maslog were *R. apiculata* (35.0 %) with some *C. tagal* (0.7 %), *H. littoralis* (0.7 %), and *B. sexangula* (0.7 %).

Table 2 shows the similarity indices in mangrove patches in the coastal barangays of Lawaan. Depending on the extent of homogeneity, the similarity of communities was categorized as highest resemblance (> 80 to 100 %), medium resemblance (> 60 to 80 %), least resemblance (> 40 to 60 %), and no resemblance (0 to 40 %; Nabi & Brahmaji 2012). Barangays Betaog and Poblacion (81.48 %) showed the highest resemblance, while majority of the sites showed medium resemblance. Maslog and Bolusao had the least resemblance (42.11 %). Adjacent barangays have almost similar resemblance as compared to those barangays that are distant from each other, for example Maslog and Bolusao. The community resemblance could be affected by the propagule dispersal capacity of some species. Propagule dispersal is a key driver of the structure and functioning of mangrove populations and communities (Van der Stocken et al. 2015).

Table 2. Index of species similarity among mangrove patches in the coastal barangays of Lawaan, Eastern Samar as of September 2017.

Barangays		
No. of species	**No. of common species**	**Similarity (%)**
Bolusao (7)	Guinob-an (4)	50.00
	Betaog (6)	54.54
	Poblacion (6)	63.16
	Taguite (6)	57.14
	Maslog (4)	42.11
Guinob-an (9)	Betaog (8)	66.67
	Poblacion (7)	66.67
	Taguite (7)	60.87
	Maslog (5)	47.62
Betaog (15)	Poblacion (11)	81.48
	Taguite (11)	75.86
	Maslog (7)	51.85
Poblacion (12)	Taguite (8)	61.54
	Maslog (7)	58.33
Taguite (14)	Maslog (9)	69.23

Smaller propagules, like the oval-shaped propagules of *Avicennia officinalis*, are dispersed over larger distances and were most sensitive to changing values as compared to larger, torpedo-shaped propagules of *Rhizophora* spp. and *C. tagal* (Di Nitto et al. 2013). Generally, the fruits of *S. alba* are small and oval-shaped making it easier to be transported by tidal flows. This can be observed by the presence of seedlings, saplings, and mature trees across the different mangrove communities in Lawaan (**Table 3**).

Table 3 shows the average number of mangrove seedlings and saplings in the coastal vegetation among the six coastal barangays in Lawaan, Eastern Samar. The species *Avicennia* sp. 1 has the greatest number of seedlings. Though this species was observed in Guinob-an, Betaog, and Poblacion, the seedling population was only observed in Poblacion. On the other hand, *R. mucronata* has the greatest number of saplings. Most of the *Rhizopora* population were observed in Guinob-an and Taguite.

Importance value

Table 4 shows the relative density, relative frequency, relative dominance, and importance value of mangrove species found in Lawaan. Generally, *S. alba* has the highest rank, while *L. racemosa* has the lowest rank. The species *R. mucronata* has the highest relative density (18.83 %), while *R. apiculata* has the highest relative frequency (20.78 %). The species with the highest relative dominance was *S. alba* (37.67 %), while *L. racemosa* has the least relative density, relative frequency, and relative dominance.

Table 3. Average number of mangrove seedlings and saplings/0.01 ha in the coastal barangays of Lawaan, Eastern Samar as of September 2017.

Species	Bolusao		Guinob-an		Betaog		Poblacion		Taguite		Maslog	
	Seedling	Sapling	Seedling	Sapling	Seedling	Sapling	Seedling	Sapling	Seedling	Sapling	Seedling	Sapling
S. alba	-	13	-	2	-	1	-	-	1	2	3	1
R. apiculata	-	-	11	12	-	2	18	4	-	9	21	23
X. granatum	-	-	-	4	13	4	2	3	-	6	13	16
R. mucronata	-	-	-	42	-	7	20	-	32	33	-	-
E. agallocha	-	-	-	1	-	-	-	-	-	-	-	-
Avicennia sp. 1	-	-	-	-	-	-	88	-	-	-	-	-
A. floridum	-	2	-	-	-	29	-	-	-	11	-	-
B. gymnorrhiza	-	-	-	-	-	-	-	1	4	3	-	2
Lumnitzera sp. 1	1	2	-	-	-	-	-	2	-	-	-	-
C. tagal	-	-	-	-	-	1	-	1	-	1	-	1
C. decandra	-	-	-	-	-	5	-	4	-	-	-	1
S. hydrophyllacea	-	-	-	-	-	-	-	-	1	1	-	-
C. philippinense	-	-	-	-	-	35	-	-	-	4	-	-
A. rumphiana	-	-	-	-	-	-	-	-	-	-	-	1
O. octodonta	-	-	-	-	-	-	-	6	-	-	-	-
R. stylosa	-	-	-	-	-	5	-	-	-	-	-	-
H. littoralis	-	3	-	3	-	-	-	-	-	1	-	-
B. sexangula	-	-	-	-	-	-	-	-	-	1	-	2
L. racemosa	-	-	-	-	-	-	-	-	1	1	-	-
Nypa fruticans	-	2	-	-	-	-	-	-	-	1	-	-
Total	**1**	**22**	**11**	**64**	**13**	**87**	**127**	**20**	**39**	**74**	**37**	**46**

Table 4. Relative density, relative frequency, relative dominance, and importance value of the mangrove species recorded in Lawaan, E. Samar in September 2017.

Species	Relative Density	Relative Frequency	Relative Dominance	Importance Value	Rank
Lawaan (21)					
S. alba	16.64	12.21	37.67	66.52	1
R. apiculata	16.83	20.78	11.26	48.87	2
X. granatum	14.60	14.51	11.99	41.09	3
R. mucronata	18.83	10.51	9.12	38.46	4
E. agallocha	7.01	4.90	10.77	22.69	5
Avicennia sp. 1	3.42	2.92	8.92	15.26	6
A. floridum	5.63	6.64	1.55	13.82	7
B. gymnorrhiza	5.32	5.18	1.57	12.07	8
Lumnitzera sp. 1	2.06	3.09	0.98	6.12	9
C. tagal	1.91	3.45	0.52	5.89	10
C. decandra	1.58	2.97	0.67	5.22	11
S. hydrophyllacea	0.91	2.49	1.08	4.47	12
C. philippinense	1.48	2.40	0.39	4.27	13
Bruguiera sp. 1	1.04	1.28	0.95	3.28	14
A. rumphiana	0.29	1.02	1.61	2.92	15
O. octodonta	0.60	1.35	0.06	2.00	16
L. littorea	0.37	0.87	0.48	1.72	17
R. stylosa	0.40	1.16	0.03	1.58	18
H. littoralis	0.36	0.98	0.13	1.46	19
B. sexangula	0.46	0.70	0.24	1.40	20
L. racemosa	0.27	0.61	0.04	0.91	21
	100.00	**100.00**	**100.00**	**300.00**	
Brgy. Bolusao (7)					
E. agallocha	21.74	11.11	42.76	75.61	1
S. alba	21.74	11.11	36.28	69.13	2
X. granatum	26.09	22.22	11.01	59.32	3
R. apiculata	8.70	22.22	5.83	36.75	4
B. gymnorrhiza	13.04	11.11	1.77	25.93	5
Lumnitzera sp. 1	4.35	11.11	1.87	17.33	6
A. floridum	4.35	11.11	0.49	15.95	7
	100.00	**100.00**	**100.00**	**300.00**	

Table 4. *continuation*

Brgy. Guinob-an (9)					
S. alba	18.75	15.39	39.15	73.29	1
R. apiculata	18.75	23.08	20.61	62.43	2
R. mucronata	18.75	15.39	3.61	37.75	3
X. granatum	12.50	7.69	9.96	30.16	4
Avicennia sp. 1	12.50	7.69	6.32	26.52	5
E. agallocha	3.13	7.69	11.01	21.83	6
Bruguiera sp. 1	6.25	7.69	5.73	19.67	7
C. tagal	6.25	7.69	1.38	15.32	8
S. hydrophyllacea	3.13	7.69	2.23	13.05	9
	100	**100**	**100**	**300**	
Brgy. Betaog (15)					
R. mucronata	43.51	16.52	19.10	79.13	1
S. alba	9.47	12.95	53.82	76.24	2
A. floridum	15.43	12.95	6.45	34.82	3
C. philippinense	7.74	12.95	1.50	22.20	4
R. apiculata	4.30	9.82	3.84	17.96	5
X. granatum	5.09	3.57	5.49	14.15	6
C. decandra	3.39	3.57	2.60	9.56	7
L. littorea	1.70	3.57	2.59	7.86	8
C. tagal	2.54	3.57	0.96	7.08	9
R. stylosa	1.72	3.13	0.05	4.90	10
Avicennia sp. 1	0.85	3.57	1.88	6.30	11
E. agallocha	1.72	3.13	1.03	5.88	12
Lumnitzera sp. 1	0.85	3.57	0.27	4.69	13
S. hydrophyllacea	0.85	3.57	0.27	4.69	14
B. gymnorrhiza	0.85	3.57	0.14	4.56	15
	100	**100**	**100**	**300**	
Poblacion (12)					
R. apiculata	23.56	17.79	18.19	59.54	1
Avicennia sp. 1	7.14	6.25	45.33	58.73	2
R. mucronata	22.36	10.10	17.53	49.98	3
X. granatum	9.37	20.19	8.13	37.69	4
S. alba	16.33	6.25	2.85	25.43	5
C. decandra	3.71	10.10	1.24	15.04	6
Lumnitzera sp. 1	7.14	3.85	3.72	14.71	7
A. floridum	7.14	6.25	0.39	13.78	8
B. gymnorrhiza	1.30	7.69	2.35	11.34	9
R. stylosa	0.65	3.85	0.11	4.60	10
C. tagal	0.65	3.85	0.09	4.58	11
E. agallocha	0.65	3.85	0.09	4.58	11
	100	**100**	**100**	**300**	

Table 4. *continuation*

Brgy. Taguite (14)					
S. alba	19.60	13.10	29.51	62.21	1
R. mucronata	26.57	12.97	13.95	53.49	2
R. apiculata	11.99	23.08	10.3	45.37	3
X. granatum	5.11	14.98	22.92	43.01	4
E. agallocha	14.83	3.65	9.74	28.22	5
A. floridum	6.88	9.52	1.95	18.36	6
B. gymnorrhiza	6.04	4.52	3.77	14.34	7
S. hydrophyllacea	1.50	3.65	3.95	9.10	8
H. littoralis	1.61	3.89	0.70	6.20	9
C. tagal	1.50	3.65	0.64	5.78	10
B. sexangula	2.22	2.22	1.29	5.73	11
C. philippinense	1.15	1.43	0.81	3.40	12
L. littorea	0.50	1.67	0.30	2.46	13
L. racemosa	0.50	1.67	0.17	2.33	14
	100	**100**	**100**	**300**	
Brgy. Maslog (12)					
S. alba	13.95	14.46	64.41	92.82	1
R. apiculata	33.69	28.68	8.80	71.16	2
X. granatum	29.44	18.38	14.41	62.23	3
A. rumphiana	1.74	6.13	9.65	17.51	4
B. gymnorrhiza	10.71	4.17	1.39	16.27	5
O. octodonta	3.58	8.09	0.33	11.99	6
R. mucronata	1.79	8.09	0.55	10.42	7
C. decandra	2.38	4.17	0.16	6.70	8
L. racemosa	1.09	1.96	0.05	3.10	9
B. sexangula	0.55	1.96	0.14	2.65	10
H. littoralis	0.55	1.96	0.08	2.59	11
C. tagal	0.55	1.96	0.05	2.55	12
	100	**100**	**100**	**300**	

Diversity and evenness

The Shannon-Wiener index categorizes the diversity of a community as very high (> 3.50), high (> 3.00), moderate (2.50 - 2.99), low (2.00 - 2.49), and very low (< 1.99). Most of the mangrove communities in Lawaan have very low diversity (**Table 5**) except for Guinob-an (2.02). Based on the results, the mangroves in Lawaan were generally under the very low diversity category.

Table 5 shows the evenness of species among the mangrove communities. The mangrove community in Guinob-an (0.92) was observed to have high evenness followed by Bolusao (0.91). This showed that the number of individuals of a species was close to the number of other species in the said communities such as *S. alba, R. apiculata, R. mucronata, X. granatum,* and *Avicennia* sp. 1 (**Table 1**). On the other hand, a considerable difference between the abundance of individual trees per species in Maslog (0.68) was observed leading to relatively the lowest evenness among mangrove communities in Lawaan.

Table 5. Diversity and evenness status of the mangrove stands in the coastal barangays of Lawaan, E. Samar as of November 2017.

Barangay	Diversity (H)	Evenness (E_h)
Bolusao	1.76	0.91
Guinob-an	2.02	0.92
Betaog	1.91	0.70
Poblacion	2.00	0.80
Taguite	1.91	0.72
Maslog	1.68	0.68
Lawaan	1.88	0.79

Anthropogenic activities and implications

Certain anthropogenic activities affecting the mangroves have been observed during the biophysical monitoring. Cutting of mangroves and planting of seedling in seagrass beds were common. Mangrove timbers were used for commercial purposes and domestic uses. Several mangrove stumps were observed in Bolusao, Maslog, and Taguite. These stumps were remnants of mangrove trees, toppled down, and were used as primary material for making charcoal. Apart from charcoal, mangrove timbers were also used as post and fencing material and firewood. An on-going construction of concrete structure was observed in the mangrove area extending to the seagrass beds in Brgy. Guinob-an. Locals revealed that mangrove patches were continuously being cleared. Further, a net fence protecting the resort from intruders has enclosed this establishment. According to the locals, there was a poultry inside the said resort.

These harmful human activities have negative implications on the mangrove ecosystem. Cutting of mangrove trees leads to the decline in the diversity of mangrove species. Building of concrete infrastructures, such as resorts, water parks, and houses, among others, will disturb the hydrology, nutrient cycling, and other flora and faunal species. With dwindling mangrove cover, these ecological services may no longer be available.

IV. Conclusion and recommendation

The rich diversity and massive cover of mangroves in Lawaan can provide several ecological and economic benefits, but only if protected, monitored, and managed properly. There is an urgent need to protect and manage the mangrove communities in Lawaan, Eastern Samar and prevent harmful anthropogenic activities. A regular community-based monitoring and protection activity, in partnership with academe and the local government unit, must be done to ensure the conservation of mangroves. It would be ideal if the local government and the communities will be made aware on the status and ecological services provided by mangroves. Various information dissemination campaigns (and production of IEC materials) should be implemented.

V. References

Cinco M. 2014. Gov't study shows 'Yolanda' damage to mangroves bigger than reported. Philippine Daily Inquirer. Date accessed: December 6, 2017. Available at: http://newsinfo.inquirer.net/607594/govt-study-shows-yolanda-damage-to-mangroves-bigger-than-reported#ixzz592beMBPg.

Di Nitto D, Erftemeijer PLA, van Beek JKL, Dahdouh-Guebas F, Higazi L, Quisthoudt K, Jayatissa LP, Koedam N. 2013. Modelling drivers of mangrove propagule dispersal and restoration of abandoned shrimp farms. Biogeosciences.

Nabi A, Brahmaji RP. 2012. Analysis of mangrove vegetation of Machilipatnam coastal region, Krishna district, Andhra Pradesh. International Journal of Environmental Science 2(3): 1754- 1764 p. ISSN 0976 – 4402.

Primavera JH. 2009. Field guide to Philippine mangroves. Philippine Tropical Forest Conservation Foundation, Inc. and Zoological Society of London. 40 pp.

Primavera JH. 2014. Mangroves of Eastern Visayas need protection. Philippine Daily Inquirer. Date accessed: December 4, 2017. Available at: http://opinion.inquirer.net/75597/mangroves-of-e-visayas-need-protection.

Primavera JH, De la Cruz MT, Montilijao C, Consunji H, de la Paz M, Rollon R, Maranan K, Samson MS, Blanco A. 2016. Preliminary assessment of post-Haiyan mangrove damage and short-term recovery in Eastern Samar, central Philippines. Marine Pollution Bulletin 109 (2). DOI10.1016/j.marpolbul.2016.05.050. Available at: https://www.researchgate.net/publication/303667925_Preliminary_assessment_of_post-Haiyan_mangrove_damage_and_short-term_recovery_in_Eastern_Samar_central_Philippines.

Resource and ecological assessment of mangroves of Lawaan, Eastern Samar. 2002. Date accessed: December 4, 2017. Available at: http://lawaan-esamar.tripod.com/mangrove/mangrove.html.

Van der Stocken T, De Ryck DJR, Vanschoenwinkel B, Deboelpaep E, Bouma TJ, Dahdouh-Guebas F, Koedam N. 2015. Impact of landscape structure on propagule dispersal in mangrove forest. Mar Prog Ecol Ser 524 (95) pp. 95-106. Doi: 10.3354/meps11206.