Journal of Environmental Science and Management Special Issue 2-2016: 39-46 ISSN 0119-1144

Damage Assessment and Recovery Monitoring of the Mangrove Forests in Calauit Island Affected by Typhoon Yolanda (Haiyan)

Pastor L. Malabrigo, Jr.[1*]
Arthur Glenn A. Umali[1]
Enrico L. Replan[2]

[1] Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños, College, Laguna
[2] School of Environmental Science and Management, University of the Philippines

*Corresponding author: plmalabrigo@up.edu.ph

ABSTRACT

Calauit island is one of the islands in the Calamian Group of Islands in northern Palawan. The island is truly blessed with bountiful mangrove resources which provide the Tagbanuas enormous economic and ecological importance. Not known to many, Calauit island became the exit point of typhoon Yolanda causing tremendous damage to mangrove area. The study assessed the extent of damage and the recovery potential of Calauit mangrove forests from the devastation of Typhoon Yolanda. Ten sampling quadrats were established in areas where trees were observed to be 100% defoliated. Individual trees (≥ 1cm diameter) inside each quadrat were measured and evaluated based on the assessment matrix developed in this study. Results of our assessment revealed serious damage of mangroves in Calauit island. About 60% of the mangrove forests was severely affected by Typhoon Yolanda. Eight months after the typhoon, 21% of the trees have fully-recovered crown (all branches were able to develop leaves), 70% are still defoliated and 22% were already dead. Four of the 10 quadrats showed high potential for recovery as evidenced by a lot of seedlings (≥ 25 seedlings) to serve as new regenerations. Conversely, there are four quadrats without any seedling recorded. Three monitoring plots were established for continuous monitoring of the recovery of the mangrove ecosystems. A course of actions was recommended to facilitate the recovery of mangroves in Caluit island, and to bring back the economic benefits from the forest.

Key words: *mangroves, Calauit island, typhoon Yolanda*

INTRODUCTION

Mangroves, also known as the "rainforests of the sea", are very peculiar plant communities that offer tremendous values and benefits to mankind and other marine and wildlife species (*Mulhall 2009*). They are important part of the coastal and marine ecosystems which include sea grasses and coral reefs. Mangroves are distributed worldwide on all continents with tropical and subtropical coasts and occur in 124 countries and territories (*Aleman et al. 2010*). As an archipelagic country made up of more than 7,100 islands, Philippines has one of the longest coastlines in the world extending up to 36,000 km (*Garcia et al. 2013*). This put the country among the top 15 most mangrove-rich countries in the world (*Long and Giri 2011*) with more than 50% of the world's total number of true mangrove species (*Primavera et al. 2004*).

Mangroves are highly regarded as the champions in environmental adaptation (*DasGupta and Shaw 2013*). There could be no other plant groups with such highly developed morphological and physiological adaptations that enable them to exist in conditions of high salinity, extreme tides, strong winds, high temperatures and muddy, anaerobic soils. The complex above-ground root structure of the mangrove forests was proven effective as shield against storm surges, strong waves, tides and currents (*Farid and Jayatissa 2009*). The appreciation on this role of mangrove forests has significantly increased in the more recent years due to more frequent occurrence of strong typhoons that endanger the life and properties of the people in the coastal communities.

Calauit island is part of the Calamian Group of Islands in northern Palawan. The island is blessed with abundant mangrove resources. Approximately 500-ha mangrove forest in Ilultuk Bay is connecting Calauit island to the mainland Busuanga (**Figure 1**). During low tides, one can actually cross from mainland Busuanga to Calauit via an exposed sand bar through the mangrove forest.

The lives of the indigenous people in the island, the Tagbanuas, are very much dependent on the mangrove forest. Many of their traditional and cultural knowledge and practices are associated with mangroves. Recognizing the importance of mangroves, primarily as breeding and

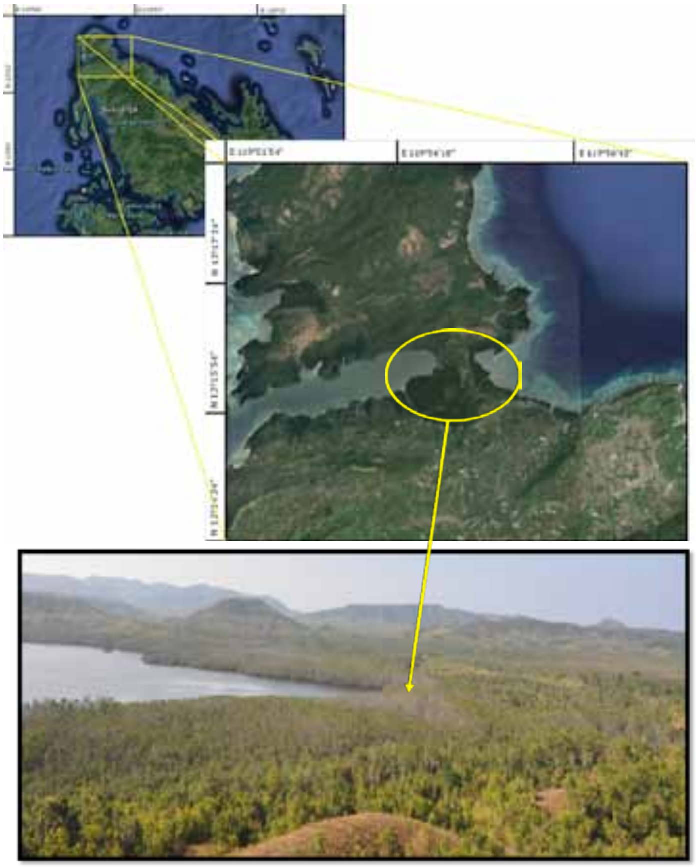

Figure 1. The large track of mangrove forest connecting Calauit island to mainland Busuanga. It should be noticed that the supposedly lash green color turned into grayish vegetation. This is because of the massive defoliation of the majority of trees.

spawning areas for many of the marine organisms, the Tagbanuas have great appreciation on mangrove ecosystems and are very committed to maintain the pristine status of their mangrove forest. Mangroves in Calauit island also serve as home to a number of ecologically important wildlife species including Philippine monkey, wild duck, Hawk's-bill turtle, and the critically endangered marine mammal – Dugong. These contribute to the high ecotourism potential of the island.

Typhoon Haiyan, locally known as Typhoon Yolanda, made a devastating landfall on November 8, 2013, in the central part of the Philippines bringing heavy rains and strong winds. It was one of the most devastating natural disasters in Philippine history causing at least 6,300 people dead and over a million houses damaged (*NDRRMC 2014*). Not known to many, Calauit island became the exit point of typhoon Yolanda causing tremendous damage to the mangroves in the area (**Figure 2**). It damaged not only the lives and properties of the people affected, but also impaired the environment. Many trees were uprooted and left with broken branches and many animals were probably displaced since their habitats were damaged. Even the mangrove forests, which supposed to serve as buffers from tides and waves, were devastated by the fury of Typhoon Yolanda. Among the most devastated areas were Guiuan, Eastern Samar; Tacloban, Leyte; and Busuanga, Palawan, where Calauit Island is located (**Figure 3**).

The general objective of the study is to assess the extent of damage of mangrove forests from the devastation of Typhoon Yolanda in Calauit Island in Busuanga, Philippines. It also aims to determine the recovery potential of the damaged ecosystems by looking at the number of seedlings and shoot development from defoliated branches. At the end, the study aims to identify management and rehabilitation strategies to facilitate the recovery ofmangroves in Caluit island, and to bring back the ecosystem services that these mangroves used to provide to the community.

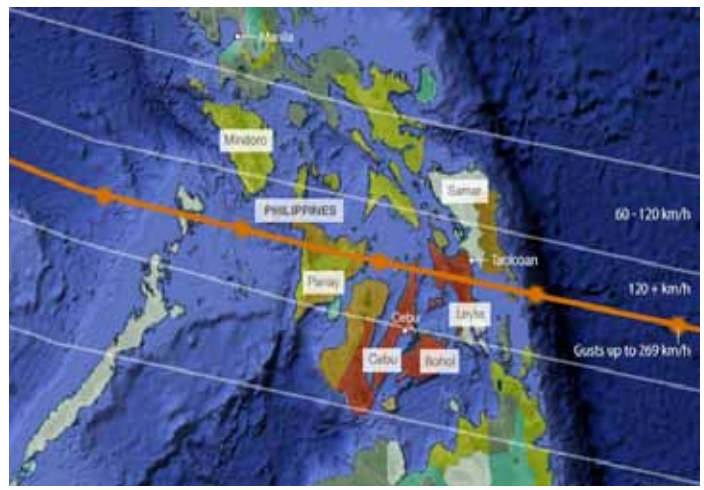

Figure 2. Path of Typhoon Yolanda (Source: http://www.bbc.com/news/world-asia-24917722).

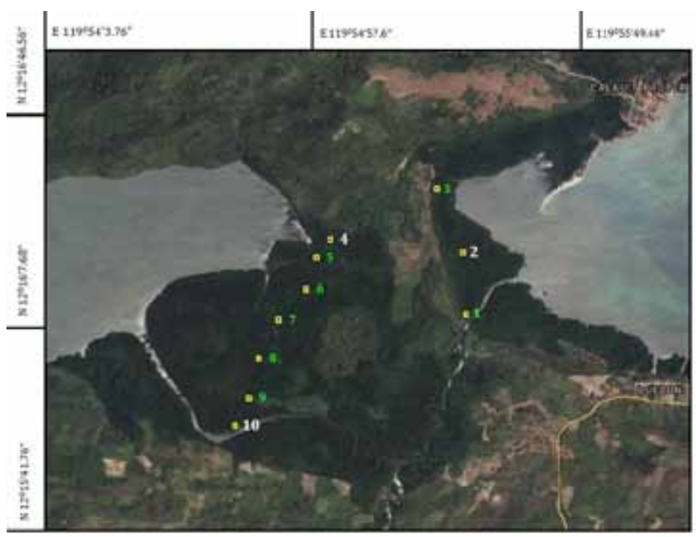

Figure 3. Location map of the ten sampling quadrats. Quadrats 2, 4, and 10 were designated as permanent monitoring quadrats where all trees (≥ 1cm) were tagged.

METHODOLOGY

The assessment was focused on Cluster 1 of Sitio Calauit, Brgy. Buluang, Busuanga, Palawan. This area contains more than 60% of the mangrove forests of the island, and was the center of devastation by Typhoon Yolanda. The study that was conducted from June 28 to July 6, 2014, made use of quadrat sampling technique to assess the extent of damage, and recovery potential of the mangroves in the area. A total of 10 (10 m x 10 m) sampling quadrats were intentionally established in the severely affected portions of the forest where trees were observed to be 100% defoliated (**Figure 2**). Individual trees (≥ 1cm diameter) inside each quadrat were measured (diameter and height) and extent of damage was evaluated using the assessment matrix developed in this study (**Table 1**). Diameter of each tree was measured 30 cm from the ground for those species that do not produced stilt roots or buttress, and 10 cm above the stilt root or buttress for those that produce. The number of seedlings or regenerants (<1 m in height), were identified and counted in each quadrat to serve as another measure of forest recovery. Three (3) of the sampling quadrats were designated as monitoring plots for future recovery monitoring. All the trees from the designated monitoring quadrats were tagged and labeled (**Figure 4**).

An opportunistic mangrove survey involving free walk and boat rides on the whole mangrove forest of Calauit island for the listing and photo documentation of the different species was also carried out to account for maximum possible species in the area. This survey allowed the team to document and approximate the extent of the entire mangrove forest.

Figure 4. Primary data collection activities: (a) Tree species identification and evaluation of damaged trees inside plot; (b) and (c) Diameter measurement; (d) Tagging of trees inside the monitoring plot.

To augment the information obtained from primary data collection, an ethno-botanical workshop was held together with the community elders (**Figure 5**), particularly the ones knowledgeable in mangrove utilization. Information regarding the local and common names as well as the traditional uses of each mangrove species were shared and discussed during the workshop. The workshop also allowed the team to verify its initial findings on the damage assessment.

Table 1. Assessment matrix for damage assessment of mangroves in Calauit Island.

Assessment Code	Illustration	Status of Assessment	Descriptive status for evaluation
1		Not damaged	No damage to crown, branches, roots and trunk
2		Defoliated	Whole crown/ branches are either devoid of leaves or defoliated by: a. 25% b. 50% c. 75% d. 100%
3		Partially Damaged	The tree is partially damaged by the typhoon leaving them with broken branches, but the tree is still standing.
4		Defoliated with some broken branches	Tree with combination of damage of 2 and 3 (with broken branches and defoliation).
5		Totally Damaged	The tree is totally damaged by the typhoon, either up-rooted or with broken main trunk.

Figure 5. Selected photos during the ethno-botanical workshop on mangroves.

RESULTS AND DISCUSSION

Diversity of Mangroves in Calauit Island

A total of 26 true mangrove taxa were documented in the entire mangrove forests of Calauit island (**Table 2**). This diversity in the area was relatively high considering that the total number of mangrove taxa in the Philippines is only 37 (*Garcia et al. 2013*). Only eight mangrove species were recorded from the sampling quadrats and majority were obtained from opportunistic survey.

Extent of Damage in Calauit Mangrove Forest

Mangroves, being natural protective barriers to wave action and storm surge, hurdled the heaviest impact of Yolanda's devastation. The observation from a vantage point at the highest ridge in the island, and actual ground survey, suggest that about 60% of the mangrove forests in Cluster 1 of Sitio Calauit, Brgy. Buluang, was severely affected by Typhoon Yolanda. About 5% were felled and majority was totally defoliated. There was no observed species or zoning pattern on affected trees. On the contrary, there was an irregular pattern of damage (defoliated trees) in the mangrove forest that would make one wonder where the strong winds came from. There were two separate bands of defoliation, meaning the defoliated trees are not contiguous (**Figure 6**). More surprisingly, the internal portions of the very thick mangrove forest were the ones more disturbed. Most of the Tagbanuas believed that there were two whirlwinds or 'tornados' that exhausted the island, hence, the erratic pattern of destruction.

Table 2. Taxonomic list of all mangrove species documented in Cluster 1, Calauit Island, Palawan (June – July 2014).

No.	Family	Species	Common name	Local name
1	Acanthaceae	*Acanthus ebracteatus* Vahl	Tigbau	Sapinit
2	Acanthaceae	*Acanthus ilicifolius* L	Diluario	Sapinit
3	Acanthaceae	*Avicennia marina* (Forsk.) Vierh. var. *marina*	Bungalon	Miapi
4	Acanthaceae	*Avicennia marina* var. rumphiana (Hallier f.) Bakh.	Piapi	Miapi
5	Acanthaceae	*Avicennia officinalis* L.	Api-api	Miapi
6	Arecaceae	*Nypa fruticans* Wurmb.	Nipa	Nipa
7	Bignoniaceae	*Dolichandrone spathacea* (L.f.) K Schum.	Tui	Tanghas
8	Combretaceae	*Lumnitzera littorea* (Jack) Voigt.	Tabau	Dublisa
9	Combretaceae	*Lumnitzera racemosa* Willd.	Kulasi	Dublisa
10	Euphorbiaceae	*Excoecaria agallocha* L.	Buta-buta	Alipata
11	Lythraceae	*Sonneratia alba J. Smith*	Pagatpat	Pagatpat
12	Lythraceae	*Sonneratia caseolaris* (L.) Engler	Pedada	Pagatpat
13	Meliaceae	*Xylocarpus granatum* Koen.	Tabigi	Tabigi
14	Meliaceae	*Xylocarpus moluccensis* (Lamk.) Roem.	Piagau	Tabigi
15	Myrsinaceae	*Aegiceras corniculatum* (L.) Balanco	Saging-saging	Sili-sili
16	Myrsinaceae	*Aegiceras floridum* Roemer and Schultes	Tinduk-tindukan	Sili-sili
17	Myrtaceae	*Osbornia octodonta* F. Muell.	Taualis	
18	Rhizophoraceae	*Bruguiera cylindrica* (L.) Bl.	Pototan lalaki	Tuki
19	Rhizophoraceae	*Bruguiera gymnorrhiza* (L.) Lamk.	Busain	Butsing
20	Rhizophoraceae	*Bruguiera sexangula* (Lour.) Poir.	Pototan	Butsing
21	Rhizophoraceae	*Ceriops tagal* (Perr.) C.B. Robinson	Tangal	Tengeg
22	Rhizophoraceae	*Ceriops zippeliana* Sheue et al.	Malatangal	Tengeg
23	Rhizophoraceae	*Rhizophora apiculata* Bl.	Bakauan lalaki	Bakau
24	Rhizophoraceae	*Rhizophora mucronata* Poir.	Bakauan babae	Bakau
25	Rhizophoraceae	*Rhizophora stylosa* Griff.	Bangkau	Bakau
26	Rubiaceae	*Scyphiphora hydrophyllacea* Gaetn. f.	Nilad	Dublisa

Figure 6. The very erratic pattern of typhoon damage in Calauit mangrove forests. Trees at the left side of the river were defoliated (a) while the other side was intact. The mid portion (b) was damaged but the adjacent areas on either side were spared.

Table 3. Number of trees damaged by category from each of the ten sampling quadrats.

Damage Category	Quadrat										Total	Percentage
	1	2	3	4	5	6	7	8	9	10		
Not damaged	16		6	1		1	1	5	11	7	48	21.43
25% defoliation	5		1	4		5	10	11	10	4	50	22.32
50% defoliation	3			5		3	3	2	2	3	21	9.38
75% defoliation		4	1	6		10	7	1	2	4	35	15.63
100% defoliation	1	19	2	4	16	7	1				50	22.32
Partially damaged	4		2					7	1		14	6.25
Defoliated with some broken branches								2		3	5	2.23
Totally damaged									1		1	0.45
	29	23	12	20	16	26	22	28	27	21	224	100

Table 4. Number of damaged trees by category by species from each of the ten sampling quadrats.

Damage Category	Species	Number of individuals										Total	Percentage
		1	2	3	4	5	6	7	8	9	10		
Not damaged	Ct	10							1	2		13	5.80
	Ea									6		6	2.68
	Ll	1										1	0.45
	Ra	1			1			1	2	1	4	10	4.46
	Rm	4		5			1				3	13	5.80
	Xg			1					2	2		5	2.23
Defoliated	Bc			1					2			1	0.45
	Ct	4										6	2.68
	Ea	4									4	8	3.57
	Ll			1								1	0.45
	Ra	1	23		18	15	15	17	11	10	9	119	53.13
	Rm				1	1	10	4			2	20	8.93
	Xg								1			1	0.45
Partially damaged	Ct	3						3				6	2.68
	Ll		2									2	0.89
	Ra							2				2	0.89
	Rm	1										1	0.45
	Xg							2				2	0.89
	Xm								1			1	0.45
Defoliated and with broken branches	Ct								1			1	0.45
	Ra								1		2	3	1.34
	Rm										1	1	0.45
Totally damaged	Ea									1		1	0.45
Total		29	23	12	20	16	26	22	28	23	25	224	100

Note: Ct – *Ceriops tagal*; Ea – *Excoecaria agallocha*; Ll – *Lumnitzera littorea*; Ra- *Rhizophora apiculata*; Rm – *Rhizophora mucronata*; Xg – *Xylocarpus granatum*; Bc – *Bruguiera cylindrica*; Xm – *Xylocarpus moluccensis*

The assessment revealed more serious damage of Calauit mangroves than what were already reported from other areas in Samar and Leyte (*Dela Paz, 2014*). Two of the ten quadrats surveyed (Q2 and Q5) were almost completely impaired. Not a single tree from Q5, a monotypic stand of Bakauan lalaki (*Rhizophora apiculata*) consisting of 16 individuals, was able to develop foliage after the total defoliation. Chopping the trunks of the trees suggest that the trees were already dead since the inner barks were already dried. In Q2, (also a pure Bakauan lalaki stand) only four (of the 23 total) individuals showed shoot development in 25% of the branches, the rest were all dead standing trees. This finding conforms with the results of damage assessment conducted by *Alura et al.* (*2015*) in the mangrove forests of Southern part of Eastern Samar.

Of the 224 total number of trees recorded from the 10 quadrats, only 48 (21%) were intact and presumed to be 100% recovered in terms of shoot development (**Table 2**). One hundred fifty-six trees were defoliated, 50 of which were still 100% defoliated and considered to be dead. There were 19 trees with broken branches. Though there was only 1 tree (a 12-cm DBH *Excoecaria agallocha*) reported to be totally damaged (uprooted), it is important to note that several uprooted trees and broken main stems were observed outside the sampling quadrats. The type of species as well as the diameter and height of the trees were not became factors to withstand the strong intensity of the typhoon Yolanda. Every species and every height class recorded different damage category (**Tables 4** and **5**).

Recovery Potential of Calauit Mangroves

Since all sampling quadrats were intentionally established in portions where trees experienced total defoliation right after the typhoon, the measured defoliation in this assessment was used as a proxy measure of recovery (i.e. a tree with 75% defoliation already have 25% recovery in terms of shoot or leaf development). Twenty-two percent of the trees in the surveyed area have no signs of recovery and more likely to die. On the positive side, 48 trees had fully recovered as evidenced by the 100% shoots development while many others were on the process of recovery (**Table 3**). The failure of the trees to develop shoots could be the combined results of excessive root disturbance brought about by the shaking effect of the strong winds plus the inability of the trees to manufacture food in the absence of leaves. This conforms with the hypothesis that many of the trees, particularly the *Rhizophora* spp., will have difficulty to recover due to its limited ability to coppice (produce new shoots from the stem) during disturbance, unlike other mangroves such as the *Avicennia* spp. and *Sonneratia* spp. Bakauan lalaki (*R. apiculata*) and bakauan babae (*R. mucronata*) accounted for the 96% (48/50) of all the trees with 100% defoliation, eight months after typhoon Yolanda. This finding coincides with the results of the study of *Carlos et al.* (*2016*) on comparison of vegetation resistance and regeneration potential of different mangroves species affected by typhoon Yolanda which revealed that *Rhizophora* species had lower vegetation resistance and recovery potential than *Sonneratia* and *Avicennia* species.

The number of seedlings or regenerants were counted and treated as another measure of forest recovery. Six of the 10 quadrats surveyed showed high potential for recovery and more likely to return to its normal functioning as evidenced by the presence of more than 25 seedlings that served as new regenerations. Q1 has the highest number of seedlings with 67, followed closely by Q3 (65), Q8 has 53, and Q10 with 25 (**Table 6**). Four of the 10 quadrats including Q5 (the quadrat with 100% mortality) have no single seedling recorded. It worsens the recovery condition of the quadrats since the dead standing trees were no longer capable of producing

Table 5. Number of damaged trees by category by species by diameter class.

Damage Category	Species	Diameter Class (cm)			Total	Percentage
		1	2	3		
Not damaged	Ct	12	1		13	5.8
	Ea	4	1	1	6	2.68
	Ll	1			1	0.45
	Ra	5	2	3	10	4.46
	Rm	5	5	3	13	5.8
	Xg	2	3		5	2.23
Defoliated	Bc	1			1	0.45
	Ct	5	1		6	2.68
	Ea	3	4	1	8	3.57
	Ll		1		1	0.45
	Ra	10	35	74	119	53.13
	Rm	1	2	17	20	8.93
	Xg	1			1	0.45
Partially damaged	Ct	5	1		6	2.68
	Ll	2			2	0.89
	Ra				0	0.89
	Rm	1			1	0.45
	Xg	2			2	0.89
	Xm	1	2		3	0.45
Defoliated and with broken branches	Ct	1			1	1.34
	Ra	1	1	1	3	0.45
	Rm			1	1	0.45
Totally damaged	Ea	1			1	0.45
Total		64	59	101	224	100

Note: Ct – *Ceriops tagal*; Ea – *Excoecaria agallocha*; Ll – *Lumnitzera littorea*; Ra- *Rhizophora apiculata*; Rm – *Rhizophora mucronata*; Xg – *Xylocarpus granatum*; Bc – *Bruguiera cylindrica*; Xm – *Xylocarpus moluccensis*

Table 6. Summary of species and number of seedlings per quadrat

Quadrat	*Rhizophora mucronata*	*Rhizophora apiculata*	*Xylocarpus granatum*	*Ceriops tagal*	Grand Total
1		4		63	67
3	62				62
7		5			5
8		5	5	43	53
9				8	8
10		25			25
Total	62	39	5	114	220

seedlings. Wave and tide actions could bring recruits, seedlings from the nearby areas. However, the crowded debris of broken trunks and branches and the dead standing trees could hinder the entry of recruits in the area. Cleaning of debris and liberation cutting of these dead standing trees could enhance the occurrence of recruits in the area.

Effects of the mangrove destruction to the community

More than 60% of mangrove trees were defoliated after Yolanda. Consequently, the massive amount of defoliated leaves brought great amount of carbon in the water that resulted to a fish kill event three days after Yolanda. The fish kill lasted for almost three weeks until the wave and tide actions slowly replaced the oxygen-deficient water in Calauit. The verdant brackish water in Calauit became a foul smelling grave. Dead fishes of all sizes floated everywhere and the toxic odor spread out even to mainland Busuanga. For more than a month, the fish kill made the community's life miserable. Local folks noticed the significant decline on the quantity and quality of their fish and crab harvest. But accordingly, the situation is improving as the mangroves are recovering. life miserable. It is very obvious that the main source of livelihood for the Tagbanuas is their fishery resources which is highly dependent on mangroves. Unfortunately, the coastal ecosystem is still not fully recovered. Local folks still noticed the significant decline on the quantity and quality of their fish and crab harvest. But accordingly, the situation is improving as the mangroves are recovering.

CONCLUSION

The damage assessment revealed that even a pristine mangrove forest, highly regarded as champions in environmental adaptations, is vulnerable to a strong typhoon such as Yolanda. The roots of the mangroves showed strong resistance to wind throw as shown by the very minimal number of trees that were uprooted. However, the canopy of the mangroves is not strong enough to hold its branches and leaves against strong winds. The susceptibility of trees to defoliation is evident in all tree species with different height class. It means that the type of species as well as the diameter and height of the trees were not factors to withstand the strong intensity of the typhoon Yolanda.

In terms of recovery from total defoliation, different species exhibited varying rates new shoots development. It was very noticeable that majority (96%) of the dead trees across quadrats were *Rhizophora* species. This can be attributed to the inability of the species to coppice or produce new shoots when stems were disturbed.

Typhoon Yolanda brought significant damage not only to the mangroves ecosystem but also to the lives of Tagbanuas that are dependent on the mangrove forest. With the destruction of the mangrove forests in Calauit, all the ecosystem services they provide may have also been imperiled. This could have significant economic and social consequences that could further contribute to reduction of livelihood opportunity and lower quality of life in the island. It is therefore necessary to have a restoration plan, including mangrove planting following the principles of ecological restoration to facilitate the recovery of mangroves in Caluit island, and to bring back the economic benefits from the forest.

RECOMMENDATIONS

Monitoring of growth, regeneration and recovery of impacted mangrove. There were three sampling quadrats designated as future monitoring plots. All trees in these plots were properly tagged and labeled. Plant growth and seedling recruitment in these plots should be regularly measured at least once a year to further monitor the recovery potential of the damaged mangroves after a heavy devastation of typhoon Yolanda.

Cleaning of debris and liberation cutting of dead standing trees. It is very noticeable that not a single seedling has been recorded in Q2 and Q5. These quadrats contain trees that were still 100% defoliated, over eight months after Yolanda. It is best to inspect those trees to assess if there are still signs of life. Those found dead should be subjected to liberation cutting. Immediate cleaning of broken trunks and branches should also be done while the woods are still usable. Aside from the benefits derived from the wood, cleaning and liberation cutting will also increase the opportunity of the area to have more seedlings recruit hence, higher chance of recovery through natural regeneration.

Enrichment planting in areas where there is massive mortality. Except for the devastated areas of typhoon Yolanda, mangrove forests in Calauit island can still be considered pristine and self-supporting. Thus, mangrove reforestation is required only to those areas with massive mortality. This mangrove planting should follow the principles of ecological restoration taking into consideration that mangrove species has a very particular zonation. There must be appropriate site-species matching and planting should be done during the right season.

Continued protection of mangrove forests. The community should continue to protect the mangrove forest in the island including the damaged but recovering trees. If mangrove encroachment can be prevented, then natural recovery of the mangroves will be facilitated.

Continued awareness campaign on the importance of mangroves. Results of the ethno-botanical workshop have proven the very rich cultural and traditional knowledge of the local people with regards to mangrove conservation and utilization. These knowledge and information should be passed on to the younger generations for the continuous appreciation and protection of the important ecosystem.

Development of an ecotourism module for Calauit. The mangrove forests of Calauit island have a great potential to be an ecotourism destination. Several *Sonneratia* (*S. alba* and *S. caseolaris*) trees were observed to attract a lot of fireflies. Many unique and critically endangered wildlife species also live inside or at the vicinity of the mangroves. These, combined with the unique very rich tradition of the tribe, can be showcased to come up with a good ecotourism module. There should be a good ecotourism plan to ensure that there will be no cultural and ecological degradation.

REFERENCES

Aleman, M. I., S.C. Bourgeois, W. Appeltans, B. Vanhoorne,N. De Hauwere, P. Stoffelen, A. Heughebaert, & F. Dahdouh-Guebas, 2010. The 'Mangrove Reference Database and Herbarium'. *Plant Ecology and Evolution* 143(2): 225-232.

Alura, D.P., Alura, N.C., Alura, R.P. C. 2015. Mangrove Forest and Seagrass Bed of Eastern Samar, Philippines: Extent of Damage by Typhoon Yolanda. *International Journal of Novel Research in Life Sciences* 2(5): 30-35

Carlos, C., Delfino, R. J., Juanico, E., David, L., Lasco, R. 2016. Vegetation resistance and regeneration potential of Rhizophora, Sonneratia, and Avicennia in the Typhoon Haiyan-affected mangroves in the Philippines: Implications on rehabilitation practices. *Climate, Disaster, and Development Journal* 1(1): 1-8

DasGupta, R., Shaw R. 2013. Changing perspectives of mangrove management in India: An analytical overview. *Ocean & Coastal Management* 80: 107-118

Dela Paz, B. 2014. Samar Mangroves Remain Resilient. The Manila Bulletin May 12, 2014. http://www.manilatimes.net/samar-mangroves-remain-resilient/96049/ Retrieved on April 18, 2016.

Farid, D.G., Jayatissa L.P. 2009. A bibliometrical review on pre- and post tsunami assumptions and facts about mangroves and other coastal vegetation as protective buffers. *Ruhuna Journal of Science* 4: 28-50

Garcia, K.B., P.L. Malabrigo, and D.T. Gevaña. 2013. Philippines' Mangrove Ecosystem: Status, Threats and Conservation in I. Faridah-Hanum, Abdul Latiff, Khalid Rehman Hakeem, and Munir Ozturk, Mangrove Ecosystems in Asia: Status, Challenges, and Management Strategies pp. 81-94. Springer-Verlag New York Inc.

Long, J. and C. Giri. 2011. Mapping the Philippines' mangrove forests using landsat imagery. *Sensors* 2011, 11:2972–2981. doi:10.3390/s110302972.

Mulhall M. (2009). Saving the rainforests of the sea: an analysis of international efforts to conserve coral reefs. Duke *Environ Law Policy Forum* 19: 321–351

National Disaster Risk Reduction and Management Council (NDRRMC). 2014. NDRRMC UPDATE. Updates re the effects of Typhhon "YOLANDA" (HAIYAN).http://www.ndrrmc.gov.ph/attachments/article/1177/Update%20Effects%20TY%20YOLANDA%2017%20April%202014.pdf

Primavera,J.H.,R.B.Sadaba,M.J.H.L.Lebata,andJ.P.Altamirano. 2004. Handbook of mangroves in the Philippines-Panay. SEAFDEC Aquaculture Department, Iloilo

ACKNOWLEDGMENT

We are grateful to the UPLB administration for creating the UPLB Task-Force Yolanda and for providing us opportunities to conduct the study and enjoy the island life of Calauit. We are also thankful to UP Pahinungod who efficiently managed and coordinated the Calauit Island Rehabilitation Program. Finally, we would like to extend our deepest gratitude to the dedicated officials of Balik Calauit Movement (BCM) under the virtuous leadership of Chairman Roy Dabuit, and to the Council of Elders of Sitio Calauit for their very warm accommodation and dynamic cooperation during the conduct of the study.