

RESEARCH ARTICLE

Success Indicators of the Philippine National Aquasilviculture Program (PNAP) - Mangrove Rehabilitation Project in Davao del Sur, Southern Philippines

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Abstract:

The study was conducted to evaluate success indicators of the Philippine National Aquasilviculture Program (PNAP) – Mangrove Rehabilitation Project in Davao del Sur. The growth increment of mangroves (cm/day) and survival and the physico-chemical parameters of the different project sites were recorded. A questionnaire was employed to gather in socio-demographic profile, best practices employed, benefits and institutional factors. The study employed one shot sampling. The growth increments of mangroves in Punta Biao (0.0032 cm/day) was comparable with Bucana (0.0031 cm/day) but were significantly higher than the rest of the project sites. Sto. Rosario exhibited the lowest growth increment of 0.0007 cm/day. In terms of survival, Bucana and Punta Biao showed the highest survival rate of 96.87% and 99.62% respectively, while San Isidro obtained the lowest mean value of 13.71%. Two (2) types of area orientation found in the different project sites, midland and tidal/mud flats. Soil types were clay loam and sandy clay. High survival and high growth increment were observed in midland area with clay loam substrate while low survival observed in seaward areas with sandy clay substrate. The pH ranged from 6.46-7.23 while salinity ranged from 23ppt-35ppt. Some of the contributing factors that influenced higher survival rate of PNAP Mangrove Rehabilitation Project in Davao del Sur include the used of matured mangrove propagates, staking prior to mangrove planting, regular monitoring at least every other day and carefully scraping epiphytes (e.g. barnacles and oysters) during mangrove's early stage. This practices observed in all project sites regardless of percentage rate recorded.

Keywords: Aquasilviculture, Mangroves

Introduction

Mangroves is the term used to categorize trees and shrubs that have grown in and have developed morphological adaptations to the inter-tidal environment (e.g. aerial roots, salt excretion glands and vivipary of seeds) and to the ecosystem. Mangroves form a distinctive ecosystem composed of peculiar plants, animals and micro flora and fauna commonly found along sheltered coastlines, shallow-water lagoons, estuaries, rivers or deltas in the tropics and sub-tropics where they perform important socio- economic and environmental functions. A majority of human population who live in coastal areas depend on local resources for their livelihood. The mangroves are sources of highly valued commercial products and fishery resources and also are sites for developing a burgeoning ecosystem. The mangrove forests provide wide range of materials for human sustenance ranging from fuel-wood collection to fisheries. The life of mangrove inhabited coastal areas depends on various goods and services provided by mangroves (Walton *et al.*, 2007).

For the past decades, the Philippine fisherfolks have been experiencing declining fish catch. Many coastal communities are also experiencing displacement due to storm surges in their areas. A major contributor to these problems is the disappearance of our mangrove forests. With this, breeding grounds of fishes were destroyed and the disappearance of natural wave barriers left communities vulnerable to storm surges. In 1995, it was recorded that there were only 117,000 hectares of mangrove forests left from a high of 500,000 hectares a century ago. Mangrove forests have been converted to fishponds, used indiscriminately as firewood and as a resource for housing construction as well as for other uses (Yparraguire, 2008).

For several decades, there has been a drastic decrease in the habitats of mangroves in the Philippines, and together with the warnings of global warming and other environmental destructions, different institutions are investing time and effort to restore the natural environment, the Philippines once had. Bringing back the habitats of mangroves is done by a lot of organizations (Samson and Rollon, 2008).

Massive rehabilitation efforts have been done for the last two decades both by the government, non-government agencies and other concerned sectors but environmental degradation remains to be an alarming issue. This pressures for development and utilization of the coastal resources particularly the mangrove ecosystem. It must be addressed within a realistic framework of conservation and sustainable resource management without jeopardizing the livelihood of the coastal fisher folks. Considering this situation, the Bureau of Fisheries and Aquatic Resources (BFAR) has partnered with the Commission on Higher Education (CHED) for the promotion of Philippine Aquasilviculture, which aims to protect and restore habitats for fisheries and aquatic resources, the establishment of community-based hatcheries, mangrove habitat rehabilitation and conservation, and providing alternative sustainable livelihood to the

community at the same time empowering them as warden of the ecosystem (Generalao *et al.*, 2014).

SPAMAST in close coordination with BFAR implemented the mangrove rehabilitation project. The ultimate purpose of this project is to rehabilitate the potential mangrove areas in the province of Davao del Sur and Davao Occidental.

Objective of the Study

The following were the objectives of this study:

1. To assess the success indicators which were based on plant growth and survival of the different PNAP mangrove rehabilitation project sites in Davao del Sur.
2. To evaluate the factors behind their PNAP success.
3. To recommend specific protocols in implementing mangrove rehabilitation programs.

MATERIALS AND METHODS

Study Area

The study was conducted in nine (9) coastal barangays of Davao del Sur to include Lawa, Don Marcelino, Buhangin, Malita, Sto. Rosario, Sta. Maria, Bagumbayan, Malalag, Balasinon, Sulop, San Isidro, Padada, Bucana, Hagonoy, Punta Biao, Digos City, and in Tagabuli, Sta. Cruz. The identified sites have existing planted mangroves as part of Philippine National Aquasilviculture Program (PNAP) – Mangrove Rehabilitation Project (Fig. 1).

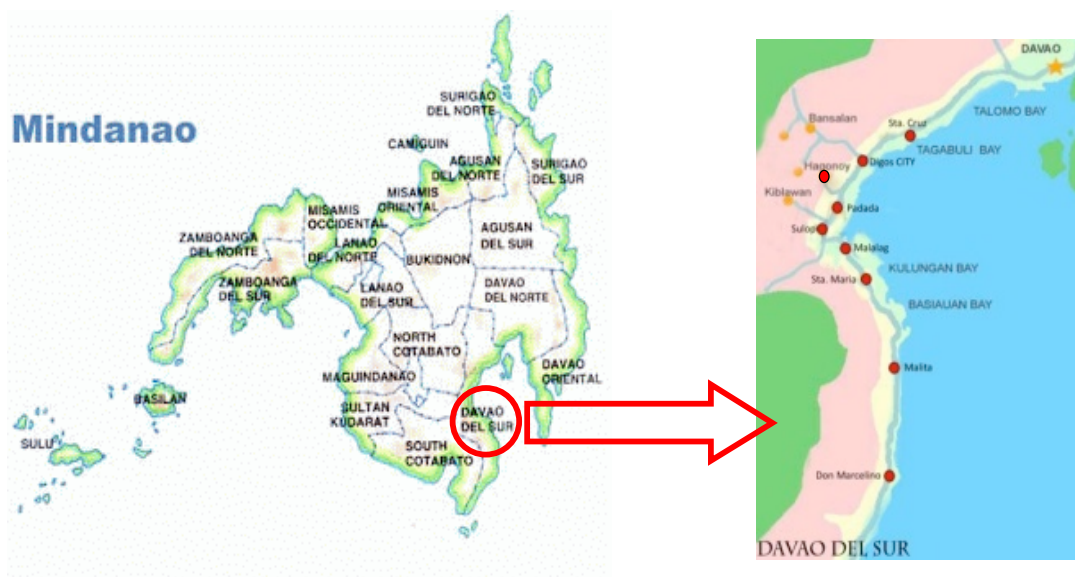


Fig. 1. The map of Davao del Sur where Philippine National Aquasilviculture Program (PNAP) – Mangrove Rehabilitation Project are situated.

Research Design and Instrument

Data in terms of growth and survival of mangroves were gathered through actual sampling, while the best practices and socio-demographic profile were gathered using questionnaires. The questionnaires were presented in Visayan dialect to facilitate understanding of question. It was administered through a personal interview.

Respondents

Respondents of the study were the PNAP mangrove rehabilitation project beneficiaries. They were randomly selected from the members of the organized beneficiaries of the nine (9) barangays. The beneficiaries are composed of fisherfolks. Thirty percent (30%) from each identified people's organization's members were considered as respondents. Active members were given priority.

Data Gathering

Growth

Growth of mangroves planted in the different study sites was determined by back calculations. Initial data on growth was based on secondary data. Final growth rate was taken by actual measurement of the planted mangroves in selected sites. Comparison on growth increment of mangroves in different study sites was based on growth increment per day.

$$\text{Growth Increment} = \frac{G_t - G_o}{T}$$

Where: G_t = is the final height of mangroves; G_o = is the initial height of mangroves; and T = total number of days cultured

Field Sampling Design

To get the growth rate of planted mangroves, sampling stations were established in different sampling sites. A 10m x 10m dimension plot was established in each sampling stations of every sampling sites. Each sampling plot serves as replicate. Spacing distance for each plot was 5 meters.

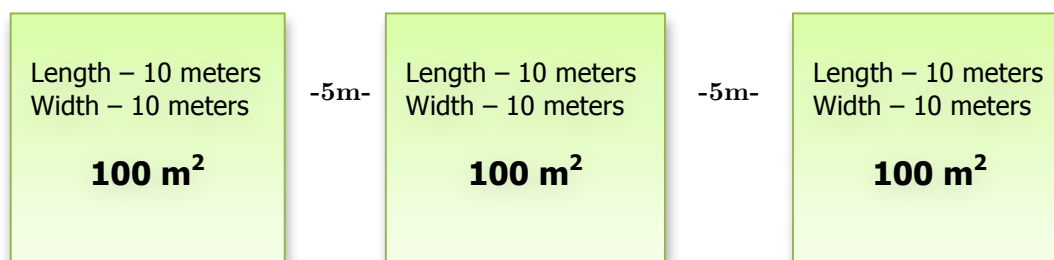


Fig. 2. The Experimental design for mangrove growth assessment and soil identification in the different project sites.

Survival Rate

The survival rate in the different areas was taken by counting the entire number of mangroves survived over the number of mangroves planted in a particular barangay. This was computed by counting the total number of planted mangroves survived at present over the total number of planted mangroves. This was aided using the formula by Primavera *et al.*, (2004).

$$\% \text{ Survival} = \frac{\text{No. of Mangroves at time (t)}}{\text{Total No. of Mangroves Planted}} \times 100$$

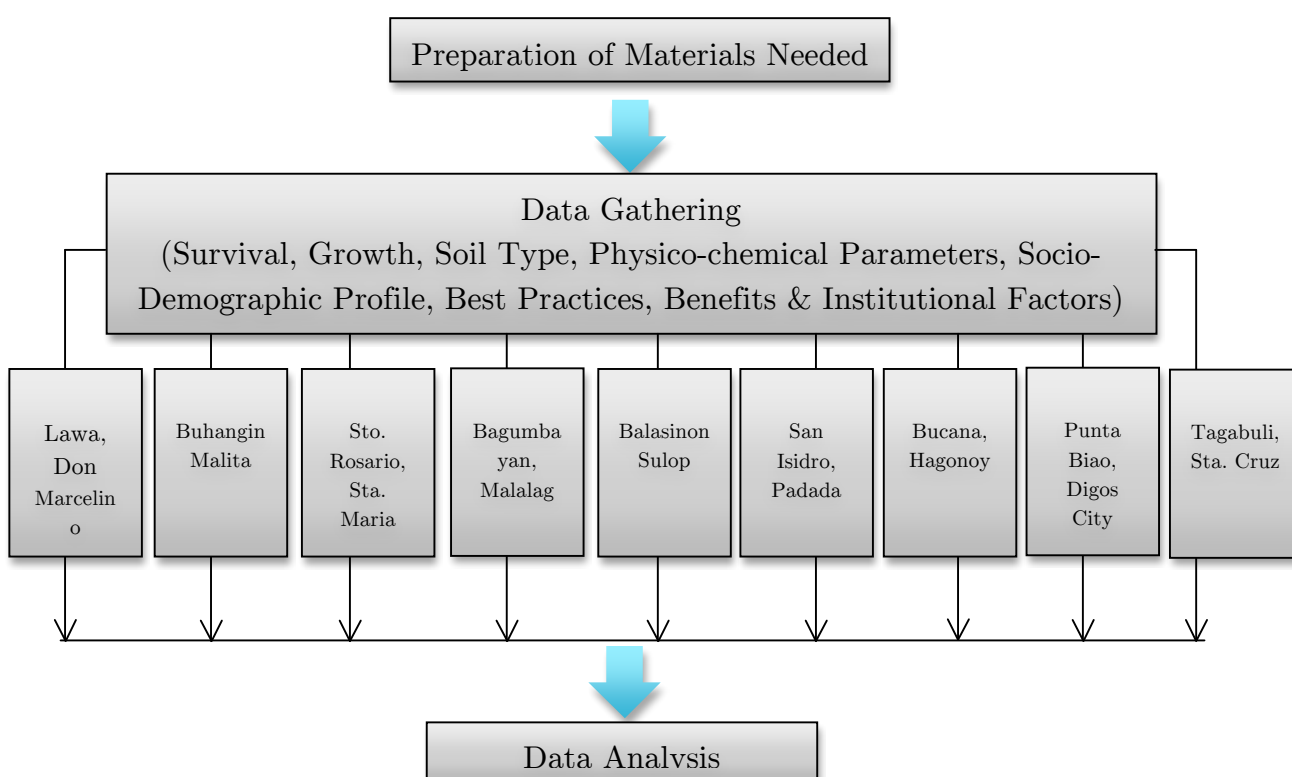


Fig. 4. Flow chart of the study

Area Orientation

Area orientation of the different study site was determined. These were into: tidal/mud flats and midland. Tidal/mud flats are shoreline area which was directly exposed to changing tidal levels and wave actions; whereas midland areas are areas exposed only during high tides and protected by heavy to moderate and sometimes no vegetation.

Soil Type Analysis

The substrates type of the different study sites were analysed using touch/feel method. Soil sample was collected from five (5) sampling points from each study site. This was collected in a depth of twenty (20) centimeters.

Statistical Analysis

Analysis of Variance (ANOVA) was used in analysing data for growth using the Statistical Package for the Social Sciences (SPSS). The results that were having significant differences were analysed further using Tukeys Test.

Percentage

This was used to determine the relative share of respondents to specific questions.

$$\% = \frac{f}{n} \times 100$$

Where: % = percentage

F = frequency

N = total no. of samples

Mean

This was used to determine the average scores of the respondents.

$$M = \frac{\Sigma x}{N}$$

Where: M = mean

Σ = summation of scores

N = total no. of scores

Results and discussion

The results on the evaluation of the Success Indicators of the Mangrove Rehabilitation Project under Philippine National Aquasilviculture Program (PNAP) in Davao del Sur are presented in this chapter.

Nine (9) Barangays were considered as study sites to provide representation of the different areas. A total of 183,000 mangrove were planted under mangrove rehabilitation project of the PNAP, but only 147,757 propagules planted in nine (9) coastal barangays of Davao del Sur were included in this study.

Growth

Result revealed that Punta Biao, Digos City and Bucana, Hagonoy were significantly higher ($p > 0.05$) than the rest of the study sites with a growth increment of 0.0032 cm/day and 0.0031 cm/day respectively (Fig. 3). Statistically, the growth rate of the seven (7) areas (Lawa, Buhangin, Sto. Rosario, Bagumbayan, Balasinon, San Isidro and Tagabuli) were not significantly different to each other ($P > 0.05$) with Sto. Rosario, Sta. Maria having the lowest growth rate of 0.0007 cm/day. Based on the different indicators evaluated (area orientation, species planted, soil type and salinity), Punta Biao and Bucana were found to be favorable to these criteria. The two (2) study sites where situated in midland areas, *Rhizophorawas* the species planted and with clay loam type of soil. No bearing on best practices as it showed the same strategies and techniques exerted by the beneficiaries with regards to monitoring, maintenance and general supervision of their respective sites (Table 6).

According to Katherisan and Moorthy 1993, shaded mangrove plants showed better growth performance compared to those plants directly exposed to sunlight. Punta Biao and Bucana mangrove plantation has an existing mangrove forest that serves as canopy of newly planted mangroves from sunlight. Intense light can damaged the mangrove and drop the photosynthetic rate (Cheeseman *et al.* 1991), hence, growth is affected.

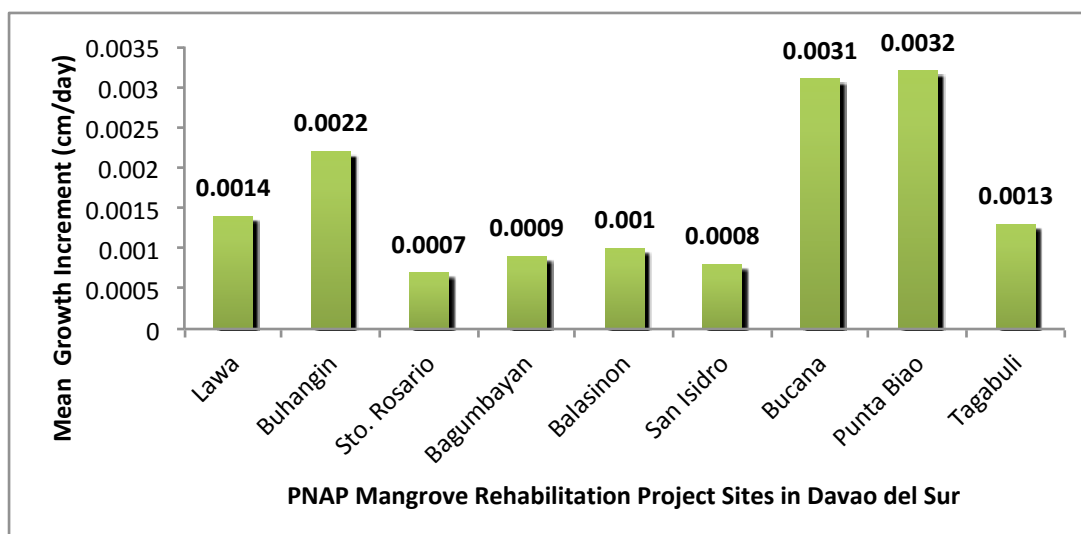


Fig. 3. Mean growth rate of mangroves planted under PNAP Mangrove Rehabilitation Project in Davao del Sur.

Survival Rate of Mangroves

Table 1 shows the survival rate of fully grown mangroves in the nine (9) study sites. The results showed an average survival of 52.99% which equivalent to an existing of 78,300 fully grown mangroves out of 147,757 planted propagules.

Results also showed that the major contributing factors to the survival of mangroves are: location of the area, species planted and soil type with other

factors having minimal effect. Bucana, Punta Biao and Lawa were the only study sites situated in midland. The first two (2) areas having the highest survival rate of 99.87% and 99.62% and Lawa with 68.95%. The area orientation of Punta Biao is in midland zone, hence, this is not directly exposed to waves and surges (Table 3).

The lowest survival was recorded in Balasinon, Sulop with 13.71%. This area is located in a seaward zone where plants are exposed directly to winds and waves.

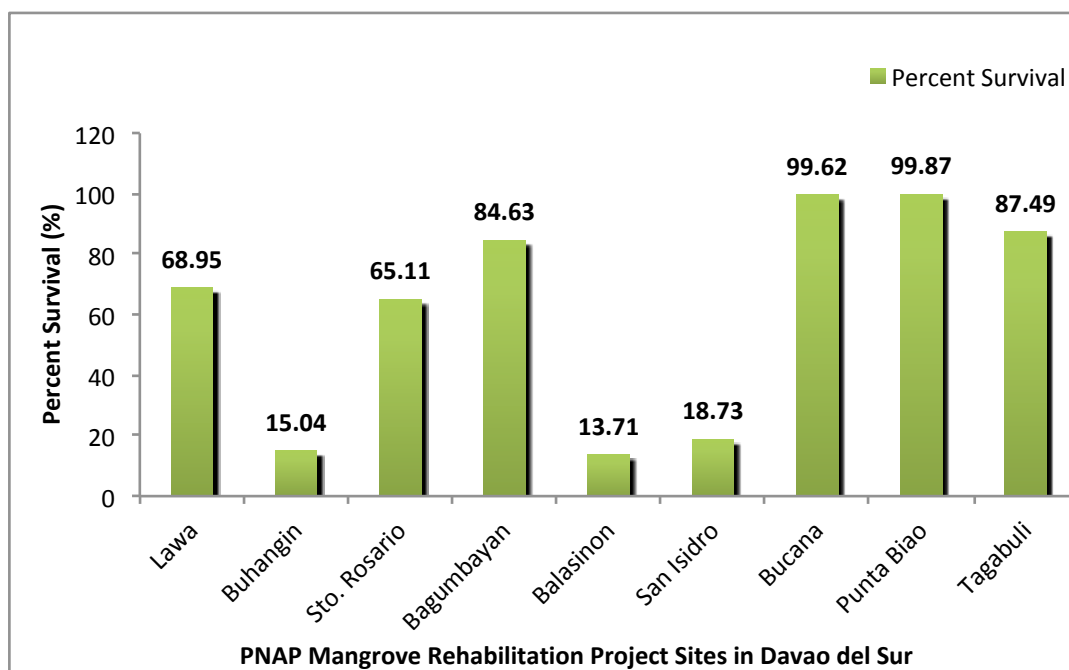


Fig. 4. The survival rate of mangroves of PNAP mangrove rehabilitation sites in Davao del Sur.

Choice of species of mangroves to be planted affects survival rate (Primavera and Esteban, 2008). These confirmed with the result of the study that *Rhizophora* species favoured clay loam soil type in the case of Punta Biao, Bucana, Lawa, Tagabuli and Sto. Rosario while Balasinon, Bagumbayan, San Isidro and Buhangin showed high mortality and recommended for other species suitable.

Best practices of the project beneficiaries showed that Punta Biao used mangroves that are matured and ripen and are ready for planting while in Balasinon, Sulop used propagated mangroves that is being nurtured in mangrove nursery for a long time (Table 6). One hundred percent (100%) of Punta Biao PO-members attested that after collecting propagules, they did direct planting. These was evidently attested why Balasinon and other seaward areas have low survival rate since bagged mangroves after planted to a specified area took time to adapt its new environment. Nonetheless, given the loss substrate of excavation and erosion caused by wave actions were possible. Direct planting may be recommended in this case.

Table 1. Summary of survival rates of mangroves planted under PNAP in selected sites in Davao del Sur.

PROJECT SITES	TOTAL PLANTED	PNAP TOTAL SURVIVAL (As of October 2014)	PERCENT SURVIVAL (%)	TOTAL SURVIVAL (As of February 28, 2015)	PERCENT SURVIVAL (%)
Lawa, Don Marcelino	16,257	15,991	98.36%	11,210	68.95%
Buhangin, Malita	21,000	3,271	15.58%	3,159	15.04%
Sto. Rosario, Sta. Maria	18,000	13,004	72.24%	11,719	65.11%
Bagumbayan, Malalag	9,000	7,881	87.57%	7,617	84.63%
Balasinon, Sulop	32,000	14,184	44.33%	4,387	13.71%
San Isidro, Padada	10,000	3,360	33.60%	1,873	18.73%
Bucana, Guihing, Hagonoy	6,500	6,500	100%	6,475	99.62%
Punta Biao, Digos City	10,000	10,000	100%	9,987	99.87%
Tagabuli, Sta. Cruz	25,000	22,000	88%	21,873	87.49%
TOTAL	147,757	96,191	65.10%	78,300	52.99%

Another finding is during the maintenance of mangroves collected. Majority of the project beneficiaries in Balasinon said that they conducted sorting of mangrove propagules and 14.29% of the total respondents confirmed that sorting activity took time up to 3 days. However, Punta Biao PO-members responded that 1 day was their maximum allotted time for stocking.

Jimenez and Lugo (1985) also mentioned that calamity like flooding is one of the causes of high mortality of planted mangroves. This could be the reason for low survival rate in Balasinon, Sulop since the area experienced periodic flash flooding, given the area is near in a populated centers where domestic waste are evident clinging to the plants (Plate 1).

Majority of the project sites in Davao del Sur used *Rhizophora* species that are endemic in their respective rehabilitation areas. Unsuitable choice of mangrove species by planting only *Rhizophora sp.* in all locations without regard to the specific-site natural mangrove zonation, is the factor most frequently reported causes of failure of mangrove rehabilitation projects in many Asia countries (Salmoet *al.*, 2007). In species selection for mangrove rehabilitation, as much as possible, mangrove restoration should involve mixed species planting, or at least species other than *Rhizophora* should be included (Macintosh and Ashton, 2002), those that are present in the area forming a stand or community.

Table 2. The mangrove species planted in the different project sites of PNAP in Davao del Sur

PROJECT SITE	SPECIES
Lawa, Don Marcelino	Rhizophora sp.
Buhangin, Malita	Rhizophora sp.
Sto. Rosario, Sta. Maria	Rhizophora sp.
Bagumbayan, Malalag	Rhizophora sp. Avicennia sp.
Balasinon, Sulop	Rhizophora sp. Avicennia sp.
San Isidro, Padada	Rhizophora sp.
Bucana, Hagonoy	Rhizophora sp.
Punta Biao, Digos City	Rhizophora sp.
Tagabuli, Sta. Cruz	Rhizophora sp.

Table 2 shows the mangrove species in different PNAP mangrove rehabilitation project sites in Davao del Sur. Bagumbayan, Malalag and Balasinon, Sulop, project beneficiaries planted mixed species of *Rhizophora* species, *Avicennia marina* and a few of *Sonneratia alba*. It is very evident that Bagumbayan, Malalag showed excellent number of mangroves survived with 84.63% using two (2) mangrove species. This is also revealed that sandy clay soil type favoured for *Avicennia* and *Sonneratia* species.

Other factors include the infestation of pest, barnacles and oysters, astray animals, the physico-chemical parameters that include water salinity, pH and the direct exposure to sunlight in the area, and the anthropogenic activities done by the local settlers (using of fishing gears, boat traffic and gleaning) have negative impacts on mangrove plantations.

Project sites close to populated areas have problem of garbage and debris (fishing nets, plastic bags etc.), and domestic animals (e.g., pigs, goat etc.). This

problem could probably contribute to the higher mortality rates of mangroves in the area.

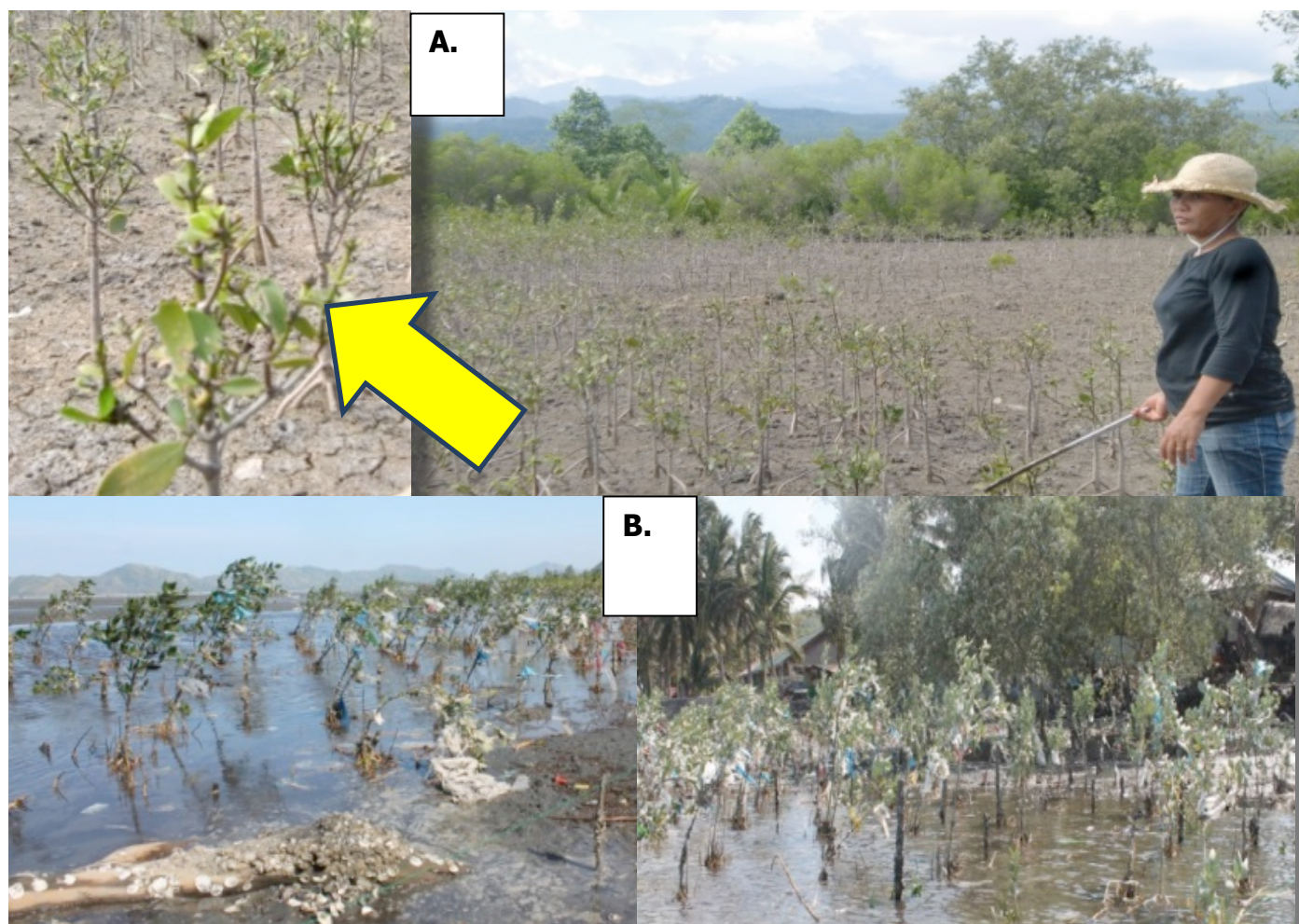


Plate 1. Damaged mangrove plantations due to (a) grazing of astray animals in Punta Biao, Digos City, and (b) garbage and debris in Balasinon, Sulop, Davao del Sur

Area Orientation and Soil Type

Table 3 shows the different substrate types and area orientation of the nine project sites under PNAP in Davao del Sur. These areas illustrated different soil texture based on the Feel Method technique as modified from Thein 1979.

Table 3. Area orientation and soil type of the different project sites of PNAP in Davao del Sur.

PROJECT SITES	AREA ORIENTATION	SOIL TYPE
Lawa, Don Marcelino	Midland Area	Clay Loam
Buhangin, Malita	Tidal/Mud Flat	Sandy Clay
Sto. Rosario, Sta. Maria	Tidal/Mud Flat	Clay Loam
Bagumbayan, Malalag	Tidal/Mud Flat	Sandy Clay
Balasinon, Sulop	Tidal/Mud Flat	Sandy Clay
San Isidro, Padada	Tidal/Mud Flat	Sandy Clay
Bucana, Hagonoy	Midland Area	Clay Loam
Punta Biao, Digos City	Midland Area	Clay Loam
Tagabuli, Sta. Cruz	Tidal/Mud Flat	Clay Loam

Buhangin, Sto. Rosario, Bagumbayan, Balasinon, San Isidro and Tagabuli areas were located in tidal/mud flats which were directly exposed to tidal occurrences and wave actions. These are the areas that with less to no vegetation within them. While Lawa, Bucana and Punta Biao areas were a midland which were exposed only to tidal occurrences during high tides and were protected by moderate vegetation present along coastline. These areas have existing mangrove trees present who mutually serve as canopy or protection for the other mangroves (saplings) to a direct exposure to sunlight.

Physico-chemical Parameters

The prevailing physico-chemical parameters observed in the different sites is presented in Table 4. The observed pH ranged from 6.46 to 7.23 and the salinity ranged from 23ppt to 35ppt.

Table 4.The physico-chemical parameters in every project site.

PROJECT SITES	SALINITY	pH
Lawa, Don Marcelino	27ppt	6.46
Buhangin, Malita	34ppt	6.48
Sto. Rosario, Sta. Maria	34ppt	7.23
Bagumbayan, Malalag	35ppt	6.78
Balasinon, Sulop	34ppt	6.75
San Isidro, Padada	29ppt	7.04
Bucana, Hagonoy	23ppt	6.81
Punta Biao, Digos City	25ppt	6.93
Tagabuli, Sta. Cruz	26ppt	7.14

The salinity in midland locations in the case of Bucana, Punta Biao and Lawa ranged from 23 to 27 ppt. These areas were planted with *Rhizophora* species of mangroves. The first two (2) areas were found to have the highest survival and growth rate among the nine (9) identified PNAP project sites in Davao del Sur. Hence, among the 9 project sites where the implementation of the project could be considered successful.

These results only confirmed the findings of Primavera and Esteban 2008, Sindh coastal community development project report 2012 that inappropriate mangrove species and sites greatly affect the survival of mangroves.

Socio-Demographic Profile of the Project Beneficiaries

The socio-demographic profile of the project beneficiaries of the nine planted locations of the mangrove rehabilitation project is presented in the succeeding paragraph. Project beneficiaries' participation in mangrove planting activities varies from site preparations to monitoring, maintenance and general supervision. Findings revealed that women have medium participation in the preparation of planting materials. However, equal participation during the actual mangrove planting activity.

Religion

Majority of the residents in the different project sites are Roman Catholic (86.44%). Out of the nine people's organizations, Lawa in Don Marcelino, Bagumbayan in Malalag, Balasinon in Sulop and Tagabuli in Sta. Cruz are Roman Catholic. Other denominations follow, such as a member of an Iglesia ni Cristo (5.08%), Baptist (3.39%) and Iglesia Filipina Independencia (5.08%).

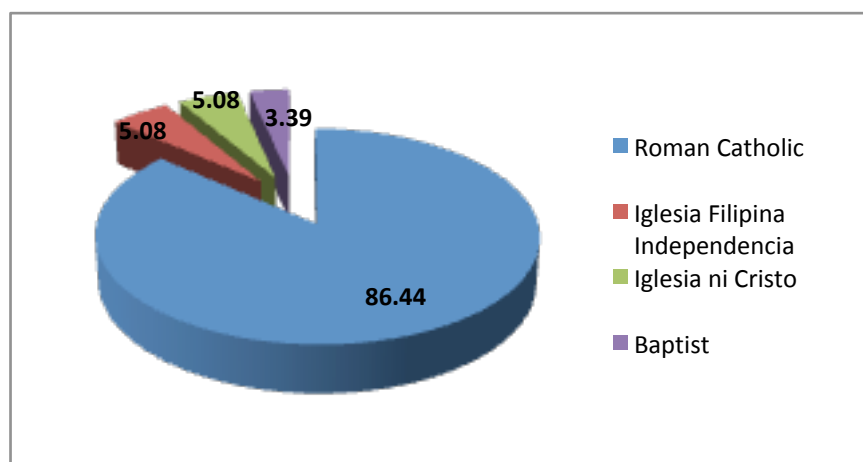


Fig. 5. The religion of PNAP project beneficiaries of the different project sites in Davao del Sur

Civil Status

As to the civil status, data shows dominance of the married member-beneficiaries with 91.53% in the barangays of Buhangin, Sto. Rosario, Balasinon, San Isidro, Bucana, Punta Biao and Tagabuli. There were only 8.47% who are single member-beneficiaries.

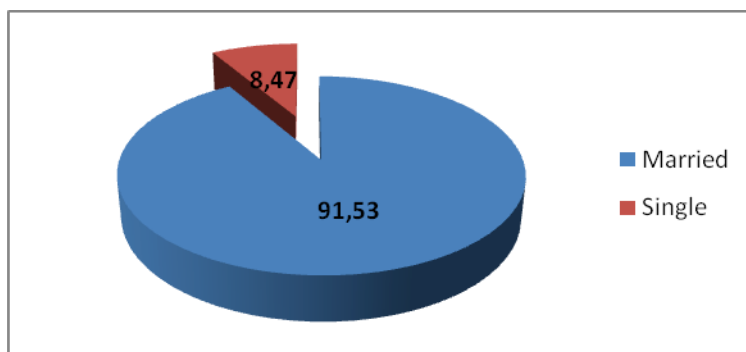


Fig. 6. The civil status of PNAP project beneficiaries of the different project sites in Davao del Sur

Occupation

Fishing is their major mean source of income with 49.15 %. Other means were as follows fish vending, gleaning, fish warden, fish cage and fishpond caretakers.

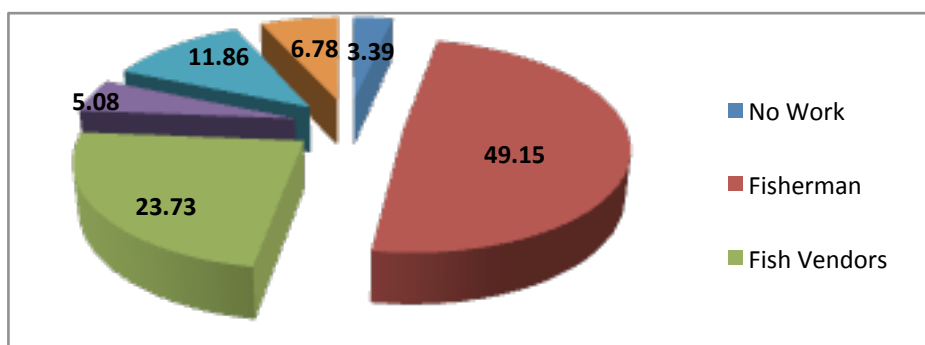


Fig. 7. The major occupations of PNAP project beneficiaries of the different project sites in Davao del Sur

Tribe

Most of the project beneficiaries were Cebuano with 83.05%, Manobo 6.78%, Kalagan 6.78% and Tagakaulo 3.39% tribes.

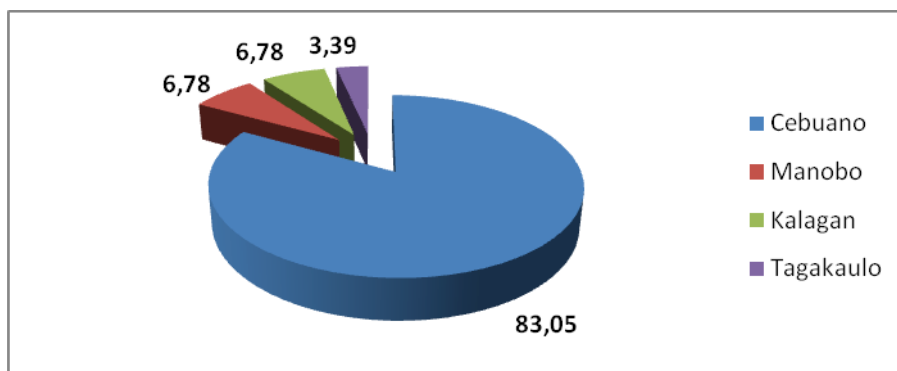


Fig. 8. The major tribes of PNAP project beneficiaries of the different project sites in Davao del Sur

Educational Attainment

Majority of the PNAP project beneficiaries are high school graduates with 54.24%, followed by elementary level with 28.81% and few of them finished college with 16.95%.

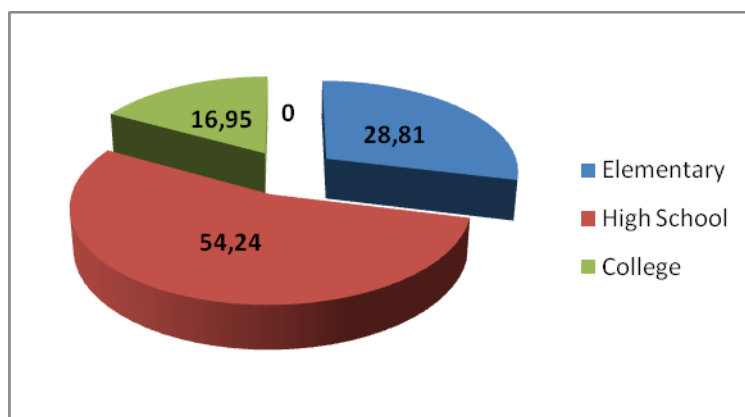


Fig. 9. The educational attainment of PNAP project beneficiaries of the different project sites in Davao del Sur

Economic Benefits

Majority (100%) of the project beneficiaries are engaged in fishing as the main source of income. One hundred percent (100%) said that all of them earned additional income ranging from Php 1,000.00 to Php 5,000.00 for every payout. Majority of them (84.75%) used their additional income in buying basic needs such as rice and viand for their daily sustenance. Others (8.47%) used it in paying tuition fees of their children and 6.78% used in paying their debt.

Environmental Benefits

Table 5 shows the environmental benefits of the project. All of the respondents agreed that the planted mangroves contributed to the increase in the fish catch in the area.

About 79.66% of the project beneficiaries interviewed conformed that mangroves provided protection to the coastal areas. Also, 81.36% of the respondents considered the planted mangroves to improve tourism in that area. The project was strongly supported by their barangay local government units (BLGU) (93.22%).

Table 5. The mean data for environmental benefits of the project beneficiaries

Total	YES		NO		Possibly	
	No. of Responses	%	No. of Responses	%	No. of Responses	%
1. Recruitment	59	100	0	0	0	0
2. Serves as protection	47	79.66	12	20.34	0	0
3. Tourist attraction	48	81.36	8	13.56	0	0
4. BLGU supported	55	93.22	1	1.69	3	5.08

Best Practices Employed by the Project Beneficiaries

The result of the evaluation on best practices employed by the project beneficiaries is presented in Table 6. Majority of the project beneficiaries said that they picked and harvested mangrove propagules by climbing the mangrove trees with 83-100% out of 8 project sites, and 16.67% of 4 barangays said that they picked from mangrove forest. No effect in selecting mangrove propagules since 100% of the 8 project sites used matured propagules for planting, except for Balasinon, Sulop (100%) that used bagged mangroves. With 83-100% (9 project sites) said that after collecting mangrove propagules, they directly planted it in their respective rehabilitation sites. Although in some cases, if the mangroves will be stocked, 71-100% said that 1 day will be a best stocking interval. Through visual observation, project beneficiaries observed that exceeding 1 day will result to infestation of pest and insects as happened in Balasinon, Sulop, Davao del Sur.

A 100% favoured of bringing mangrove propagules in the project sites were aided using sack, plastic handlers and the like. Before mangrove planting activity, 40-100% (8 project sites) of the project beneficiaries said that they did area preparations like making markings where to plant mangroves. Other activities employed were the establishment of stakes to support the planted mangroves as it grows and protected from being uprooted caused by tidal actions and other factors.

On the actual day of planting, 25-100% of the total respondents recommended to make a hole before placing the mangroves on a specified area. It was aided using digging materials, shovel and others.

Regular monitoring is fundamental in determining whether objectives of reforestation have been achieved. In this case, a majority or 62.71% of the total respondents said that they monitor the planted mangroves in every other day. Few of them practiced scraping activity to the body of the mangrove propagules to minimize the infestation of barnacles and oysters, for instance.

Table 6. The responses of the PNAP project beneficiaries in terms of best practices employed

Sampling Stations	LAWA		BUHANG IN		STO. ROSARIO		BAGUMB AYAN		BALASIN ON		SAN ISIDRO		BUCANA		PUNTA BIAO		TAGABUL I	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%	of Res pons es	%
1.Collection of Mangrove Propagules																		
A. From Trees	12	100	6	100	4	66.67	1	20	7	100	5	83.33	5	83.33	5	83.33	5	83.33
B. From Shoreline	-	-	-	-	1	16.67	1	20	-	-	-	-	-	-	-	-	-	-
C. From Forest	-	-	-	-	1	16.67	3	60	-	-	1	16.67	1	16.67	1	16.67	-	-
2.Selection of Mangrove Propagules																		
A. Matured	12	100	6	100	6	100	5	100	-	-	6	100	6	100	6	100	5	100
B. w/ Roots	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Bagged Mangroves	-	-	-	-	-	-	-	-	7	100	-	-	-	-	-	-	-	-
3.Maintenance before Mangrove Planting																		
A. Stocked before Planted	1	8.33	-	-	-	-	-	-	-	-	6	100	-	-	-	-	-	-
B. Direct Planting	1	8.33	6	100	6	100	4	80	-	-	-	-	-	-	6	100	5	100
E. Sort before Planting	10	83.33	-	-	-	-	1	20	7	100	-	-	6	100	-	-	-	-
4.Stocking Period (in days) before it was Planted																		
A. 1 Day	10	83.33	6	100	6	100	5	100	5	71.43	6	100	4	66.67	6	100	5	100
B. 2 Days	2	16.67	-	-	-	-	-	-	1	14.29	-	-	1	16.67	-	-	-	-
C. 3 Days	-	-	-	-	-	-	-	-	1	14.29	-	-	1	16.67	-	-	-	-
5.Means of transporting Mangrove Propagules																		
A. Packed	12	100	6	100	6	100	5	100	7	100	6	100	6	100	6	100	5	100

6.Preparations prior to Mangrove Planting

A.Markings	10	83.33	3	50	6	100	3	60	-	-	-	-	-	-	-	-	-	-
B. Used of Lines	1	8.33	3	50	-	-	2	40	7	100	6	100	6	100	5	83.33	5	100
C.Landmarks	1	8.33	-	-	-	-	-	-	-	-	-	-	-	-	1	16.67	-	-

7.Mangrove Planting Strategies and Techniques

A. Direct sticking	-	-	-	-	-	-	-	-	-	-	3	50	-	-	-	-	-	-
B. Used of Digging																		
Materials	9	75	-	-	-	-	-	-	-	-	2	33.33	-	-	-	-	2	40
C. Hole Making	3	25	6	100	6	100	3	60	3	42.86	1	16.67	6	100	6	100	3	60
D. Grown																		
Propagules	-	-	-	-	-	-	2	40	4	57.14	-	-	-	-	-	-	-	-
E. Tying	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

8 .1. Maintenance in terms of guarding and monitoring

A. Everyday	-	-	-	-	-	-	-	-	5	71.43	-	-	-	-	-	-	-	-
B. Every other Day	12	100	6	100	4	66.67	4	80	2	28.57	-	-	-	-	4	66.67	5	100
C. Once a Week	-	-	-	-	2	33.33	1	20	-	-	6	100	6	100	2	33.33	0	0
D. Twice a Week	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

8.2. Maintenance in terms of Cleaning and General Supervision

A. Everyday																		
Cleaning	-	-	-	-	-	-	2	40	4	57.14	2	33.33	2	33.33	3	50	-	-
B. Scraping																		
Regularly	-	-	3	50	3	50	-	-	2	28.57	-	-	-	-	-	-	5	100
C. Tying	12	100	3	50	-	-	2	40	1	14.29	-	-	-	-	-	-	-	-
D. Fencing	-	-	-	-	3	50	1	20	-	-	4	66.67	4	66.67	3	50	-	-

Institutional Factors

Keys informants of the project were also given a questionnaire to give some feedbacks about the overall attainment of the project. Key informants include the Community Organizers (COs), Project and Study Leaders, DA-BFAR Technical Staff, Project Monitoring Office (PMO) among others. One Hundred Percent (100%) attested that there is an executed memorandum of agreements (MOA) of the Bureau of Fisheries & Aquatic Resources (BFAR) and the Southern Philippines Agri-business and Marine and Aquatic School of Technology (SPAMAST) in implementing the Philippine National Aquasilviculture Program (PNAP). To ensure effective implementation, project team members was given training like hands-on training on resource rehabilitation and aquasilviculture, leadership training and capability building workshop and the like.

Regional Steering Committee (RSC) was created and existed to supervised policy implementation and oversee the Project Monitoring Office (PMO). RSC scheduled to meet yearly for 1-3 times or more as the need arises. In Davao del Sur, the Project Monitoring Office (PMO) existed to oversee the operations and implementation of the program in the province. Three (3) Community Organizers were hired to facilitate and implement PNAP in the grassroot levels. Community Organizers were rated excellent or 1.83 in project presentation to Local Government Units (LGUs), Barangay Local Government Units (BLGUs) and People's Organizations (POs). They organized and strengthened people's organizations who served as project beneficiaries and front liners during the whole project duration. They were tasked also to conduct trainings and dissemination of information, and supervised mangrove planting, maintenance and general supervision of the different project sites. A mean satisfactory rating of 2 for the promotion of environmental awareness, value formations, team building, gender awareness and related technical aspects in the project implementation. As well as in ensuring appropriate, accurate and timely payment of financial obligations to the project beneficiaries, community organizers got mean satisfactory rating of 2.17.

There is a need of an integrated strategy for rehabilitation of degraded ecosystems together with conservation such that rehabilitation that improves livelihoods of local communities (Tabuchi, 2003). Evidence in this study for institutional factors indicated that community organizers hired got a satisfactory rating of 2.17 which might be implies that something should be addressed on the management strategies, as such, the timely payment of financial obligations to the project beneficiaries does not regularly achieved on a specified day and time due to government protocols of processing cash and related expenses. This was confirmed with 33.33% of the PO-members in Sto. Rosario, Sta. Maria that the guarding and general supervision of the rehabilitated sites was conducted once a week.

The Department of Environment and Natural Resources (DENR) – Community Environment and Natural Resources (CENRO) also extended their technical assistance. DENR-CENRO serves as technical consultant, like in the case of San Isidro, Padada and Balasinon, Sulop on which PNAP Mangrove Rehabilitation Project are situated. The above-stated areas are in line with the

DENR's Key Biodiversity Areas (KBA) and in thrust with the Integrated Coastal Zonation Mapping Plan (IZCMP) of their respective municipalities.

Majority of the PNAP Mangrove Rehabilitation Project sites were identified as Key Biodiversity Areas (KBAs). These are the areas identified reforestation/afforestation sites. Most of the project beneficiaries met the criteria as recipient's sets by the management and in validation of the Fisheries and Aquatic Resources Management Councils (FARMCs). They're willing to participate in the program implementation and abide by the terms and conditions therein. They're also bonafide resident fisherfolks in their respective barangays and identified and included in the list as marginal sector.

Key informants rated excellently as to PNAP objectives of ensuring resource sustainability, attaining food security and contribute in alleviating poverty incidence.

Summary, conclusions and recommendation

Summary

The study was conducted in the barangays of Lawa in Don Marcelino, Buhangin in Malita, Sto. Rosario in Sta. Maria, Bagumbayan in Malalag, Balasinon in Sulop, San Isidro in Padada, Bucana in Hagonoy, Punta Biao in Digos City, and in Tagabuli in Sta. Cruz, Davao del Sur from February 21 to 28, 2015.

The study aimed to evaluate the success indicators of which was based on survival and growth of mangroves planted under mangrove rehabilitation project of the Philippine National Aquasilviculture Program (PNAP) in the nine planted areas mentioned. Actual measurement of height and survival of mangroves in the different project sites made through a one shot sampling.

Results revealed significant difference ($P < .05$) in terms in growth in length (cm/day) obtained among the nine planted areas. Punta Biao, Digos City has exhibited the highest increment of 0.0032367 cm/day and Sto. Rosario, Sta. Maria as lowest mean height of 0.0006667 cm/day. In terms of survival rate, the highest was observed in Punta Biao, Digos City with 99.87% and followed by Bucana, Guihing, Hagonoy with 99.62%. The lowest was recorded in Balasinon, Sulop with 13.71%.

There were two (2) type of area orientation found in the different project sites, midland and tidal/mud flats areas. Clay loam and sandy clay were identified as soil types. High survival and high growth increment was observed in midland area and with clay loam type of soil. Low survival in seaward area. pH reading will range from 6.46 and 7.23 while salinity will also range from 23ppt – 35ppt.

Some of the contributing factors that influenced higher survival rate of PNAP Mangrove Rehabilitation Project in Davao del Sur includes the used of matured mangrove propagules, staking prior to mangrove planting, regular monitoring at least every other day and carefully scraping epiphytes (e.g. barnacles and oysters) during mangrove's early stage. This practices observed in all project sites regardless of percentage rate recorded.

Conclusions

Among the nine project sites, Bucana, Hagonoy and Punta Biao in Digos City showed higher survival rates of PNAP planted mangroves in the province. The lowest was recorded in San Isidro, Padada. These were attributed with soil type, area orientation, species selection, physico-chemical parameters. Survival rate and growth increment will be dependent on its area orientation, soil type and appropriate species.

The selection of appropriate species of mangroves in Davao del Sur should be considered. The presence of mangrove species thriving in the area could be a guide. This also reveals that the species of *Rhizophora* is favourable only in clay loam soil type (common in tidal/mudflat) and *Avicennia* for sandy clay soil (common in seaward areas).

Some best practices revealed staking, used of matured propagules, regular monitoring and scraping contributed to high survival rates.

Recommendations

The used of mixed mangrove species for mangrove rehabilitation project such as *Avicennia* and *Sonneratia* species are recommended to use when conducting mangrove planting activity in seaward areas having high water salinity.

For an efficient direct planting activity, staking is highly recommended to support the plant against wave actions, epiphytes (e.g. barnacles and oysters) and protected from being uprooted caused by other factors.

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Appendix I

SUMMARY DATA AND ANALYSIS OF VARIANCE (ANOVA) OF THE GROWTH RATE (cm/day) OF MANGROVES PLANTED UNDER THE PHILIPPINE NATIONAL AQUASILVICULTURE PROGRAM (PNAP) – MANGROVE REHABILITATION PROJECTS IN DAVAO DEL SUR, PHILIPPINES

Project Sites	REPLICATION			TREATMENT	TREATMENT
	1	2	3	TOTAL	MEAN
Lawa, Don Marcelino	0.0017	0.0013	0.0012	0.0042	0.0014
Buhangin, Malita	0.00102	0.00121	0.0013	0.00353	0.001176667
Sto. Rosario, Sta. Maria	0.0007	0.0006	0.0007	0.002	0.000666667
Bagumbayan, Malalag	0.00018	0.0011	0.0015	0.00278	0.000926667
Balasinon, Sulop	0.00044	0.0006	0.002	0.00304	0.001013333
San Isidro, Padada	0.0005	0.0008	0.0011	0.0024	0.0008
Bucana, Hagonoy	0.0033	0.0031	0.003	0.0094	0.003133333
Punta Biao, Digos City	0.0035	0.0032	0.003	0.0097	0.003233333
Tagabuli, Sta. Cruz	0.0014	0.0013	0.0011	0.0038	0.001266667
GRAND TOTAL				0.04085	
GRAND MEAN					0.001512963

Analysis of Variance (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	8	.000	17.239	.000
Within Groups	.000	18	.000		
TOTAL	.000	26			