Science teachers and coastal dwellers perceptions on mangrove biodiversity conservation

Percepciones de los maestros de ciencia y habitantes costeros sobre conservación de la biodiversidad de manglar

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Abstract

Biodiversity loss in natural coastal systems such as the mangroves is now a major global issue threatening sustainability. This issue became more intense with the aftermath of the deadly tsunamis that hit many countries in South Asia. The loss of human lives among the coastal dwelling population and destruction of the coastal vegetation in these countries have resulted in a renewed focus on the mangrove resources. Many governments and scientific organizations have rekindled their interest in rehabilitating/regenerating lost mangrove stands with the involvement of people's organizations, non-governmental organizations (NGOs) and educational institutions. Education at all levels has been responding in various ways to this global issue so as to abate the rapid depletion of the remaining mangroves. Science education in this regard, remains inextricably linked with biodiversity conservation and the sustainable use of natural systems. Life science teachers are considered the most fitting group to help the people understand the interdependence of various ecosystems in the coastal zone and the vitality of conserving the biodiversity of mangroves that serve communal groups on a long-term basis. The purpose of this paper is to contribute insights about science teachers' and coastal dwellers' (or "mangrovellers") perceptions on the extent of the utilization of mangrove resources, values and benefits of mangrove biodiversity conservation and educational aspects on the conservation of mangroves in a typhoon-prone island province in Luzon, Philippines. The general agreement of science teachers and coastal dwellers on ecological values such as protection from flood, erosion and other climatic factors indicate that indeed local people are aware of the "free" services of mangrove ecosystem. Their perceptions were found significant to the various educational initiatives (i.e. instruction, research and community service) in support of various programs on sustainable use, rational management and biodiversity conservation (SURMABIOCON) of mangroves in the Philippines. The paper also includes suggested science teaching initiatives by bringing students to the world of mangroves.

Key words*: mangroves, biodiversity, conservation, science teachers, perceptions, coastal dwellers, mangrovellers, Philippines.*

Resumen

La pérdida de la biodiversidad en sistemas costeros naturales como los mangles, es un gran problema mundial, muy importante, que amenaza su sostenibilidad. Esto se hizo más intenso a causa del efecto de los tsunamis mortales que, golpeó muchos países en Sur de Asia, con la pérdida de vidas humanas entre la población de morada costera, y la destrucción de vegetación. Los maestros de ciencias, son considerados los que tienen como mayor propósito, ayudar a la gente a comprender la interdependencia de varios ecosistemas en la zona costera y la vitalidad de conservar la biodiversidad de mangles que sirven a la comunidad en un largo plazo. El objetivo de este artículo es contribuir en las explicaciones sobre las percepciones de los maestros de ciencia y, habitantes costeros en el intento de utilizar recursos mangles, de los valores y beneficios de conservación de mangles en una isla propensa al tifón como en las islas Catanduanes, Luzón, Filipinas. El acuerdo general de profesores de ciencia y los habitantes costeros en valores ecológicos como la protección contra inundación, erosión y otros factores climáticos, indican que efectivamente las personas locales son conscientes del "libre" servicio del ecosistema de mangle. Sus percepciones fueron importantes a las varias iniciativas educacionales (instrucción, investigación y servicio a la comunidad) en apoyo de varios programas sobre uso sostenible, administración racional y conservación de biodiversidad de mangles en Filipinas. El artículo incluye también propuestas para instrucción científica preliminar, para acercar al estudiante al mundo de los mangles.

Palabras clave: *mangles, biodiversidad, conservación y protección del medio ambiente, maestros de ciencia, percepciones, habitantes costeros, Filipinas.*

INTRODUCTION

The Asia Pacific region has many small islands wherein the marine coastal vegetation, such as mangroves, has direct and indirect uses for the coastal dwelling communities. The most important characteristic of the mangroves in the coastal ecosystem from the ecological and economic point of views is biodiversity. The mangroves are continuously being destroyed in the Philippines and other countries in Southeast Asia (SASEKUMAR, 1993). And in some cases, threatened and endangered species are lost. Human uses for the mangroves can have negative effects on the ecological processes of mangrove ecosystems. Major stresses like climate changes, increasing human populations and the influence of the changing geophysical and geomorphic processes can contribute to the changes in the structure and function of mangroves (TWILLEY, 1998).

Hence, the principles of biodiversity conservation of mangroves and their sustainable development cannot be properly addressed if other development issues are not considered. Education, in this regard, remains inextricably linked with biodiversity conservation and the sustainable use of these mangroves. Educational management as a social process has to focus on the effective and efficient achievement of the determined goal of a certain country to conserve the nation's biodiversity. Science teaching as a vital area in education can carry out activities on the characterization, assessment and dissemination of information about the country's mangrove biodiversity. It is a known fact in the Philippines that life science teachers are said to be the most fitting group to help the people understand the interdependence of systems, which serve communal groups on a long-term basis (FOLLOSCO, 1991).

According to HAMILTON and SNEDAKER (1984), the first step towards the attainment of the goals of sustainable use and preservation of the mangrove ecosystem is to develop a database (a comprehensive collection of information on such subjects as the areas of distribution of mangroves, their flora and fauna, present and potential yields from various uses, and the socio-economic structure of human population dependent on the resource). Likewise, it is vital to know the people's perceptions about their environment (WARNER, 1981) considering that the anthropogenic aspects of any natural ecosystems (i.e. mangroves) are components of the cultural diversity in the most recent concept of biodiversity.

This study attempted to determine the perceptions of science teachers and coastal dwellers on 1) the extent of the utilization of mangrove resources, values and benefits of mangrove biodiversity conservation, and 2) the educational aspects for the conservation of mangroves in an island province in the Bicol region (Luzon, Philippines). This island is frequented by typhoons (=tropical cyclones) and is being used as a reference point in tracking this natural disturbance. The paper also provides information on the appropriate topics for science teaching and research on the mangroves as suggested by the respondents of the present study.

Science teachers and coastal dwellers (i.e. members of mangrove and fishermen associations and other mangrove inhabitants) in small islands of the Philippine archipelago are expected to have immense contribution in the maintenance of the general health conditions of mangroves in the country. Although there are several reports about the local peoples' concern about the rapid degradation of mangroves in the country, there are also reports that raised the issue on the lack of concern of the local people in the conservation of these natural resources. For instance, the study of CORTES (1986) and that of ACUÑA (1988) have corroborated that students and

secondary school teachers in the Philippines lack environmental awareness and values.

This study therefore was undertaken in order to address the lack of awareness and doubtful judgment about the environment. The need to compare the views of these two groups of respondents (i.e. science teachers and coastal dwellers) about mangrove biodiversity and conservation is vital to a deeper understanding of the environmental awareness and values of the local communities in the country and elsewhere in the world. Moreover, the coastal dwellers, specifically the members of various mangrove and fishermen association are sometimes misunderstood and much worse, would also be victims of unscrupulous non-governmental organizations (NGOs) and other environmental groups in the country trying to short-change them of the appropriate community-based programs that protect the nation's biodiversity. Furthermore, the study aimed to gather information from the two groups of respondents about the desired role of schools in mangrove biodiversity conservation in the Philippines as well as suggestions on what topics are significant for teaching and doing research on mangroves in the country. The results of the study are expected to provide the bases in determine the appropriate educational management initiatives of various environmental groups, science teachers and administrators of schools and higher educational institutions (HEI). These groups play leading roles in mangrove rehabilitation or in the regeneration of mangrove areas in tropical countries such as the Philippines and other areas in the Asia Pacific region recently damaged by tsunamis.

MATERIALS AND METHODS

Study Area Catanduanes in the Bicol Region, Luzon is situated on the Eastern part of the Philippine archipelago (13.5 to 14.1° N, 124 to 125.5° E). Highest elevation of the island is 803 m above sea level and with a total area of 1,483.84 sq km. The island is a huge mountain mass with very limited coastal plains. The climate is tropical and monsoonal.

Research Design This study is a descriptive survey using the questionnaire as the main research instrument and interview guide. The questionnaire used was pre-tested in a coastal village or *barangay* in one of the municipalities of the island. The questionnaire was designed and constructed for both science teachers and coastal dwellers. Science teacher respondents were those assigned in schools about 3 km away from the mangrove areas under study. The coastal dwellers are mostly members of mangrove associations (also termed as "mangrovellers" in the study) and fishermen cooperatives. Some key informants were also self-selected from the *barangays* to get more information on mangrove biodiversity conservation. The researcher mingled with the coastal dwellers by attending regular meetings of the "mangrovellers".

RESULTS AND DISCUSSION

The Respondents. As shown in table 1, there were 404 respondents (117 science teachers or 27.8% and 287 or 71.03% coastal dwellers) involved this study.

Gender and Age of Respondents. There were 228 (or 56.4%) males and 171 (43.6%) females. For the coastal dwellers, the majority of the respondents are males (218 or 76%), while the female samples comprise 24% or 69 respondents. Majority of the science teacher-respondents are females which comprised 91.5%. There were only 10 (or 8.5 %) male science teachers involved in the study. A total of 130 (32.2%) respondents were aged 20 and below; 147 respondents (36.4%) were aged between 21-30 years old; 62 (or 15.35%) respondents were aged 31-40 years; 34 (or 8.42%) respondents were aged 41-50 years; 21 respondents were aged 51-60 years; and only 10 (2.48%) respondents were aged 61 or more years.

Table 1
Age of the respondents (Science Teachers and Coastal Dwellers) involved in this study (n=404)

Age Range	N° of Respondents	Percentage (%)
20 years old & below	130	32.18
21 to 30 years old	147	36.39
31 to 30 years old	62	15.35
41 to 50 years old	34	8.42
51 to 60 years old	21	5.20
61 and above	10	2.48

Education and Occupation. The science teacher respondents are expected to have finished at least a Bachelor's degree or their college education. Majority of the coastal dwellers (table 2) have graduated from secondary school (170 or 57.3%); 16 or 5.41% have some secondary schooling; 28 or 9.46% graduated from elementary schools; 19 or 6.42% have some elementary schooling; 53 or 17.91% have entered college; and only 10 or 3.38% have college degrees. There were 117 science teachers (28.9%); 98 (24.3%) work as fishermen; 39 (9.7%) are laborers; 29 (7.2%) are farmers; 24 (5.9%) are government workers and 15 ((3.7%) are tricycle drivers. There were 63 (15.6%) students interviewed and another 19 (4.7%) respondents who have various jobs either as vendors, carpenters, machinist, caretakers of fishponds or as security guards.

Table 2
Occupation of the respondents involved in this study

Occupation	N° of Respondents	Percentage (%)
Science Teachers	117	28.9
Fishermen	98	24.3
Students and youth	63	15.6
Laborers	39	9.7
Farmers	29	7.2
Government Employees	24	5.9
Tricycle drivers	15	3.7
Others, i.e. *vendors, carpenters, machinist*	19	4.7

Residency. There were 352 (87.3%) respondents who are living permanently near or within the mangrove areas under study, while 52 (12.87%) of the respondents live temporarily there. Most of these temporary residents are working or studying in the nation's capital of Manila. Some are working in another municipality or town and some have permanent residencies away from their school being served. Nineteen (or 4.7%) respondents have resided in the mangrove area for less than a year; 95 (23.5%) respondents stayed in the place from 1 to 5 years; 135 (33.4%) stayed in the place for 6-10 years; 153 respondents (37.9%) stayed in the place for 11 and above years; and 2 (0.5%) respondents did not specify their answers.

Perceptions held by Science Teachers and Coastal Dwellers on the Extent of Utilization of Mangrove Resources

Table 3 shows the perceptions of the respondents on the extent of the utilization of mangrove resources. As perceived by the two groups of respondents, mangroves are mostly utilized for household purposes, finfish and mollusk gathering (for food consumption) and for recreation purposes. The least of these uses are for paper products and leather production.

Table 3
Summary of weighted scores on **p**erceptions regarding the extent of utilization of mangrove resources in Catanduanes island, Luzon, Philippines

Uses	Total Sample	Coastal Dwellers	Science Teachers
Fuel	2.37	2.43	2.31
Construction	2.35	3.43	3.29
Fishing (for commercial use)	2.36	2.57	2.15
Agriculture	3.14	3.71	2.75
Paper Products	1.23	1.18	1.29
Food, Drugs, Medicines	2.34	2.53	2.14
Household	3.34	3.44	3.23
Textile & Leather	1.98	2.18	1.79
Finfish & Crab collection for food consumption in the family	3.75	3.89	3.61
Bees, Birds, etc.	2.46	2.67	2.24
Recreational	3.65	3.64	3.68

A test of the significant difference between the variances of measurements for the mean weighted responses (F- ratio) of the two groups of respondents was accomplished (table 5). It can be gleaned from this table that areas on fuel, construction, drug and medical uses were known to have

no differences in terms of the extent of utilization as perceived by the two groups of respondents. Perceptions differ as to the extent of the use of mangrove resources for fishing (commercial use), paper products and collection of bees, birds (e.g. herons) and reptiles (e.g. *Varanus salvator, V. olivaceous*).

Perceptions on the Values and Benefits of Mangroves in Catanduanes Island

The two groups of respondents were asked about their level of agreement about the values and benefits of the ecological and economic aspects of the conservation of mangroves. table 6 shows the summary of average weighted scores obtained in determining the perceptions of science teachers and coastal dwellers.

1. *Grazing Role of Animals (e.g. grass feeders) in the Mangrove Ecosystem.* A greater number of the respondents (141 respondents or 35.52%) strongly disagreed that grazing animals can disturb the mangrove ecosystem by hindering growth, development and productivity. Only 55 respondents or 13.85% strongly agreed to the above statement; 64 respondents or 16.12% agreed; 117 respondents or 29.5% disagreed; and only 20 respondents or 5.04% were undecided.
2. *Effects of Increasing Human Population to the Mangrove Ecosystem.* There were 180 respondents or 44.9% who strongly agreed that increasing human population would have effects on the richness of mangrove trees in the ecosystem. For the remaining respondents, 28.2% (113) agreed; 11.7% (47) disagreed; another 11% (45 respondents) strongly disagreed; and only 4% (or 16 respondents) were undecided.
3. *Aesthetic Value of the Mangrove Ecosystems.* Majority of the respondents (216 or 53.7%) strongly agreed on the beauty of the numerous mangrove trees and other plants in the province. There were 95 respondents or 23.6% who agreed to the aesthetic value of mangroves in the province; 43 respondents or 10.7% disagreed and strongly disagreed about the aesthetic value of the mangroves; and only 5 respondents or 1.3 % was undecided and some did not provide responses.
4. *Attractiveness or 'Magnetic Power' of the Mangrove Ecosystems for Tourismic or Eco-Tourismic Value*. There were 136 respondents or 34.3% who strongly agreed to the attractiveness of the mangrove ecosystems as tourismic value; 129 respondents or 32.5% agreed; 70 respondents or 17.6% disagreed; 51 respondents or 12.8% strongly disagreed about the tourismic value of the mangrove ecosystems in Catanduanes; and 11 respondents or 3% were undecided.
5. *Mangroves as Wastelands.* There were 93 respondents or 24.5% who strongly agreed that mangrove areas are wastelands; 75 respondents or 20% agreed; 56 respondents or 15% disagreed; 149 respondents or 39% strongly disagreed that people should value mangroves as wastelands; and 7 respondents or 2% were undecided.
6. *Mangroves as Habitats.* Perceptions of the respondents seem to be very diverse. Percentage-wise, their judgment on the 4 spectra (except the spectrum on Undecided) showed to have at least 20% of the respondents. There were 81 respondents or 20% who agreed strongly; 89 respondents or 22% agreed; 87 respondents or 21.8% disagreed; 99 respondents or 25% strongly disagreed; and a greater number of respondents were undecided (42 respondents or 11%). This is one aspect, wherein the local people have not fully understood that mangrove ecosystems are places where fish are protected and being nourished. The various mangrove root and trunk systems are places where smaller animals are able to hide.
7. *Recreational Value of Mangroves.* There were 84 respondents (21%) who strongly agreed that mangroves can be venues for recreation and tourism; 81 respondents or 20% agreed; 93 or 23.5% disagreed; and 104 respondents or 26.3% strongly disagreed. There were 34 respondents (or 9%) who were undecided.
8. *Effects of Climate on Mangrove Biodiversity.* Majority of the respondents (228 or 56%) strongly agreed that climatic conditions could regulate or control the richness of mangroves in Catanduanes. There were 104 respondents or 26% who agreed; 34 respondents or 8% who disagreed about this value; 23 or 6% who strongly disagreed; and 17 respondents or 4% were undecided.
9. *Effects of Insect Pests and Parasites on Mangroves.* There were 103 respondents or 6% who strongly agreed that pests and parasites can reduce the richness of mangroves; 136 respondents or 35% agreed; 69 respondents or 18% disagreed; 39 respondents or 10% disagreed strongly; and 46 respondents or 12% were undecided.
10. *Mangrove Areas as Sources of Nipa Palms for the Shingle ("Tiklad") Industry)*. Majority of the respondents (217 or 56%) strongly agreed that mangrove areas in the province are good sources of nipa palms used as thatching materials for nipa shingles. There were 87 respondents (or 23%) who agreed; and only 28 respondents or 7% who disagreed strongly.

A result of a t-test, the p value (0.510756) is less than the critical value ($p > 0.05$ and 0.01). The perceptions on the ecologic and economic values of conserving mangroves of science teachers do not differ from that of the coastal dwellers in Catanduanes Island.

Perceptions Regarding the Extent of Implementation of Mangrove Conservation Programs/Projects in Catanduanes Island, Luzon, Philippines

Table 4
Summary of results on the F- ratio test on the significant difference in the perceptions of science teachers (ST) and coastal dwellers (CD) on the extent of utilizing mangrove resources

Areas	Computed Value	Tabular Value of F	Decision	Interpretation
Fuel	1.1005	5.05* 10.97**	Do not reject Ho	No significant difference
Construction	1.18 7.0**	3.79*		
Fishing	10.426	5.05* 10.97**	Reject Ho	Slightly significant difference
Agriculture	7.051	161* 4052**	Do not reject Ho	No significant difference
Paper Products	100.15	19* 99.01**	Reject Ho	Significant difference
Food, Drugs, Medicines 7.000**	1.6712	3.79*	Do not reject Ho	No significant difference
Household Uses	2.004	3.44* 6.03**	Do not reject Ho	No significant difference
Textile and Leather	2.7385	19.00* 99.00**	Do not reject Ho	No significant difference
Finfish, Crabs	2.4856	9.28*	Do not reject Ho	No significant difference
Bees, Birds and Reptiles	36.339	9.28* 29.46**	Reject Ho	Highly significant difference
Recreational Uses	1.507	3.79**	Do not reject Ho	No significant difference

Ho: There is no significant difference between the perceptions of mangrovellers and those of the science teachers on the extent of utilization of mangrove products or resources. Note: * Tabular value at 0.05 level of significance; ** Tabular value at 0.01 level of significance

Table 5
Average weighted scores (AWS) on the perceptions of science teachers (ST) and coastal dwellers regarding the values/benefits of conserving mangrove resources

Items	CD	ST	Both AWS	Quantitative Response
1. Grazing animals disturb the mangrove ecosystem by hindering growth, development and productivity.	2.90	3.07	2.99	3.0
2. An increase of population in the community will have effects on the richness of mangrove trees of "bakawan" (*Rhizophora* spp.).	3.71	4.97	4.34	4.0
3. I appreciate the beauty of the numerous trees and other plants in the mangrove ecosystem.	4.07	4.63	4.35	4.0
4. People from other *barangays* (local villages) or places come to the mangrove ecosystem for recreation of such activities as bird catching, boating and diving.	3.90	4.26	4.08	4.0
5. It is proper for local people to use the mangrove ecosystem for waste disposal; anyway the garbage will just be carried by the seawater.	3.45	2.42	2.94	3.0
6. Mangroves are conserved to protect habitats of fish, crabs and other aquatic organisms.	2.83	3.57	3.20	3.0
7. Mangrove conservation can preserve the recreational and tourism activities of the barangay (local village).	2.89	3.35	3.12	3.0
8. Climate such as rainfall patterns can regulate or control the richness of the mangroves in the locality.	4.06	4.16	4.11	4.0
9. Insect pests and univalves found on the leaves of mangroves regulate or reduce the richness of the "bakawan" in the ecosystem.	3.22	3.74	3.49	3.0
10. Mangrove areas are very good sources of nipa palms (*Nypa fruticans*) used as thatching material for shingle making or "tiklad" (*N. fruticans* shingle industry).	4.26	3.74	3.99	4.0

Table 6 shows the summary of scores on the perceptions of the respondents regarding the extent of the implementation of mangrove conservation programs/projects in the island. Both types of respondents perceived that *barangay* (local village) resolutions on garbage disposal and an expert system in mangrove biodiversity conservation are "sometimes" implemented. The respondents gave the general response of "never" on programs and projects on mangrove biodiversity conservation, viz.: ecotourism project, mangrove reserve project, school mangrove forest park, aquasilviculture, computer-learning projects on mangroves and local field guides on mangroves.

Table 6
Summary of the findings on the perceptions among science teachers and coastal dwellers regarding the conservation of mangrove ecosystems

Items	Coastal Dwellers	Science Teachers
Nipa palms now are very few because many people gather these without the permit from the government.	3.615	3.516
It is proper for barangay officials and the municipal (=town) government to construct fishponds and beach resort near or within the mangrove ecosystem.	3.517	2.763
A park for local and foreign tourists can be a good project for the school and the community officials.	3.253	4.605
Mangroves prevent coastal erosion in our area.	3.398	4.985
Mangroves can maintain and preserve the beauty of our environment.	4.368	4.996
Mangroves ensure fuel supply for the community.	4.691	4.851
Mean	3.80706	4.35454
Std. Dev.	0.581838	0.875925
Variance	0.338536	0.767245

A Wilcoxon Rank Sum analyzed the significant difference in the perceptions held by the respondents on the frequency or occurrence of the various programs and projects on the conservation of mangroves. Results show that z=1.274118 and p=0.202631. The z value is not equal to or greater than 1.96 (p>.05) and 2.58 (p> .01). Thus, the data indicates that the two groups of respondents are in agreement with the extent to which these programs/projects are implemented. Coastal dwellers, who are mostly members of mangrove associations and fishermen's cooperatives have been exposed to various media such as leaflets, film showings, video programs, lights and sounds when non-governmental organizations (NGOs) and the provincial office of the environment and natural resources ministry of the country have given orientation programs, seminars and other modes of information dissemination campaign. On the other hand, the science teachers acquired their knowledge about these mangrove biodiversity conservation programs and projects through readings, attendance to seminars and conferences on science teaching and biology conferences.

Educational Management Aspects of Conserving the Mangrove Ecosystems

This component of the survey was included to generate information needed in developing appropriate educational management programs on instruction, research and extension activities related to the mangrove ecosystems. Instructional materials for environmental education and science teaching in the elementary, secondary and tertiary levels were prepared.

Table 7
Summary of data on the perceptions regarding the extent of implementation of mangrove conservation programs in Catanduanes Island, Luzon

Project/Activity	Average Weighted Score	Rank
Expert Visitation	3.15	1
Barangay Garbage Disposal Project	2.69	2
Tree Planting of Mangroves	2.38	3
Mangrove Reserve Project	2.35	4
Aqua-Silviculture Project	2.20	5
Field Guide Materials	1.97	6
School Mangrove Park	1.83	7
Computer Learning Project on Mangroves	1.75	8
Eco-tourism Project	1.72	9
Museum/Reference Projects	1.26	10

1. *Perceived Involvement of Schools in the Conservation of Mangroves.* The respondents were asked whether schools must be involved in the conservation of mangrove resources. A total of 347 respondents (or 85.9%) said yes; 40 (9.9%) said no; and 17 (or 4.2%) said not sure. This shows that schools can assist the government in various conservation

program initiatives.

2. *Areas by which Schools can Assist in the Conservation of Mangroves*. A total of 260 (64.35%) respondents perceived that schools must be involved in the planning of programs/projects; 210 (51.98%) respondents said that schools are should be involved in the implementation of programs on biodiversity conservation; 299 (74%) respondents expressed that schools should be involved only in information dissemination and 177 (43.81%) of the respondents said that schools should participate in monitoring and evaluation of projects. The respondents suggested that schools are to be engaged in planning, implementation and information dissemination campaigns. The lowest number of respondents subscribed to doing monitoring and evaluation. This is basically the responsibility of the local environmental agency.
3. *Recommended Topics for Teaching and Research of Teachers*. In the survey questionnaire, several topics were listed for the respondents to evaluate in terms of importance as teaching and research topics. The results of this survey are presented in Tables 8 and 9.

Table 8
Suggested topics for inclusion in the curriculum or teaching modules of science teachers

Topics	Mean Weighted Score	Rank
Mangroves protect floods	2.85	1
Mangrove plants in the locality	2.70	2
Effects of cutting mangroves	2.69	3
Why mangroves should be conserved	2.66	4
Effects of pollution on mangroves	2.50	5
Government regulations about mangroves	2.38	6
How to plant mangroves	2.34	7
How to grow mangroves	2.33	8
Preparation of medicines from mangrove trees	1.91	9
Making of vinegar and alcohol	1.88	10
Making of crab-trap materials	1.50	11
Fishes in the mangrove Area	1.49	12
Making of decor from mangroves	1.48	13
How to catch fish, crabs, etc.	1.42	14
How to make Nipa *(N.fruticans*) shingles	1.20	15

4. *Extension Activities About Mangrove Ecosystem*. Teacher respondents and some mangrovellers were asked to choose and evaluate possible programs and projects which can be implemented in their respective localities. Results of the evaluation made are shown in table 10.

Table 9
Suggested research topics for science teachers

Topics	*Mean Weighted Score*	*Rank*
Role of science teachers in mangrove conservation	2.78	1
Policies on sustainable use of mangroves	2.65	2
How to regenerate degraded mangroves	2.53	3
Nutrient flow/cycling in mangroves	2.49	4
Effects of calamities	2.46	5
Human impacts on mangroves	2.43	6
Genetic diversity of mangroves	2.43	6
Peoples' responses to mangrove degradation	2.26	7
How to regenerate degraded mangrove Areas	2.26	7
Mangroves as alternatives to Rainforests	2.22	8
Policies on mangrove management	2.19	9
Infractions/violations on mangrove laws	2.15	10
Gender and development in mangrove communities	2.15	10
Peoples response to mangrove degradation	2.13	11
Mangrove-fisheries interactions	2.07	12
Role of mangroves on sea grass beds	2.07	12
Efficiency/effectiveness of NGO-assisted projects on mangrove reforestation	2.06	13
Mangroves as model ecosystems	2.03	13
Role of mangroves on the productivity of mangals	1.93	14
Perceptions of mangrove dwellers on economic development	1.90	15
Abundance of fish and shrimps in mangrove Areas	1.85	16
Poverty in mangrove communities	1.78	17
Malaria/dengue in mangrove areas	1.65	18
Health status of children in mangroves	1.64	19
Ownership and conflicts on land tenure	1.63	20
Epidemiology in mangrove areas	1.54	21

Table 10
Perceived extension programs/projects on mangrove conservation

Programs	Mean Score	Rank
Mangrove Reserve for Study of Students	2.56	1
Mangrove Eco-Tourism	2.55	2
Mangrove Research Center	2.54	3
Mangrovetum/Reference Center/Museum	2.47	4
Mangrove Forest Park	2.25	5
Learning of New Mangrove Planting Methods	1.62	6

The marine coastal ecosystems of small islands in the Philippine archipelago have great connections with the human populations. In mangrove areas, several connections occur in terms of the benefits derived and materials extracted by the coastal dwelling families. Aside from the multiple and sustained "free" services provided by mangrove ecosystems, a range of direct and indirect products from mangroves forms the basis for mangrove-dependent economic activities (HAMILTON and SNEDAKER 1984). Several mangrove-dependent activities were observed in the island under study by determining the views of the two groups of respondents (science teachers and coastal dwellers). This focused on the issue about the lack of awareness of teachers and local people in the area.

Like any other small islands in the Asia Pacific region, the coastal dwellers of the island under study have utilized mangrove resources in many different ways. They depend on wood and non-wood products as well as the economically important species of mangrove-associated fauna such as finfishes (mullets, siganids, groupers, and gobiids), mollusks (bivalves) and crustaceans (shrimps and crabs) both for commercial purposes and home consumption. Unfortunately, these coastal-dwelling people will continue to exploit these various mangrove resources for economic reasons, but they might not be able to consider the reduction of biodiversity in the mangroves. Reduction in biodiversity is expected to have connections in the over-all productivity and sustainability of the mangrove ecosystem. This seems to have slipped the attention of most of the coastal dwellers in highly degraded mangrove areas in the country which need more investigation. Any educational management initiative being done at present and for the future should start with knowing the views of these groups of local people to ensure success or effectiveness. These views of science teachers and coastal dwellers about the ecologic and economic benefits of conserving the biodiversity of mangroves served as bases for designing appropriate educational initiatives in support of the government's campaign to conserve the nation's biodiversity. The results could serve as bases in stimulating schools to integrate mangrove biodiversity conservation in instruction, research and extension.

The results clearly indicate that science teachers and coastal dwellers are well aware of the different benefits of utilizing mangrove resources and with the view of protecting or conserving these resources. Science teachers and coastal dwellers generally agree on ecological values such as protection from flood, erosion and other climatic factors, indicating that the local people are knowledgeable about the "free" benefits of mangrove ecosystems. The issue raised by Cortes (1986), that secondary teachers lack environmental awareness and values, does not support the present findings in this island province of the country. The coastal dwellers are also aware of the ecological value of mangroves and the extent of utilization and conservation of mangroves, which would indicate that indeed they do not lack concern for conserving the biodiversity of mangroves. In this case, coastal dwellers are not expected to be the problem in the quest for the protection of mangrove resources, but rather these dwellers appears

to understand and differentiate the short-term and long-term benefits of conserving mangroves.

Regarding mangrove resource utilization, the study reveals that some resources are not harnessed (*e.g.* as source of paper and leather, as well as the direct source of fuel, fish, crabs, shrimps and palm (*Nypa fruticans*) products). The respondents positively perceived that mangrove resources are valuable so that there is a need to undertake more biodiversity conservation activities. The general agreement among the two groups of respondents on the ecological values (e.g. protection from floods or strong waves, erosion and other climatic factors) indicates that indeed local people are aware of these "free" services of mangrove ecosystems. On the economic aspect, it appears that utilization of the different mangrove resources will continue or will be practiced as long as the resources are still there.

Contrary to the previous reports of DELORINO and GELERA (1992) from the Visayas region in the Philippines, the existing mangrove resource scenario in the study is not painted with a "bleak future". Although there are signs of over-exploitation of mangrove resources in some areas, their dynamic system provides for natural regeneration to take place after a strong tropical cyclone. The human or anthropogenic impact could still be minimized due to the minimal increase in population density and number in the island province under study.

CONCLUSIONS, IMPLICATIONS TO EDUCATIONAL MANAGEMENT AND RECOMMENDATIONS

Based on the results of the study, the following conclusions can be drawn:

- As perceived by science teachers and coastal dwellers, the agriculture and household uses of the mangrove resources are the most utilized in this island of the Philippine archipelago under investigation.
- Paper, textile and leather production are the least perceived activities carried out in the utilization of mangrove resources in the study area.
- Except for the three uses of mangrove resources, *viz.:* for fishing (commercial), paper products and direct products from bees, birds and reptiles, the views of coastal dwellers do not differ to those of the science teachers on the extent of utilization of other direct and indirect resources.
- The perceptions of the two groups of respondents are the same regarding the ecologic and economic values of conserving the mangroves and the extent of the implementation of programs/projects on mangrove biodiversity conservation in the province.

Implications to Science Education

One of the roles of higher educational institutions (HEIs) in the Philippines is to assist the government, not only on the generation of relevant information base for the future valuation of mangrove resources, but also in monitoring and evaluating projects on mangrove conservation and rehabilitation. This aspect was noted in the present study when the two groups of respondents perceived that these institutions can perform such roles. The economic valuation of mangroves in other parts of the country, e.g. Pagbilao in Quezon, Luzon (see JANSEN and PADILLA 1997) was basically hampered by the lack of solid information about the mangrove structure and function. With this situation, schools and HEIs could provide inputs to mangrove biodiversity conservation.

With the recent destruction brought about by the tsunamis in SEA, policies which are deemed necessary in taking actions towards mangrove biodiversity conservation and sustainable use are as follows:

- Increasing and sustaining the budgets of schools/HEIs having mangrove areas for production in order to explore researches pertaining to mangrove biodiversity and sustainable uses.
- Instituting policies that involve basic education and HEIs in establishing centers for coastal marine studies and mangrove educational centers in areas having "strict" mangal communities.
- Institutionalizing a community-based nature conservation program for mangroves through the Youth Environment Corps and developing video or web-based mangrove educational kits. These materials highlight the role of mangroves in flooding, tidal waves and tsunamis.
- Instituting policies to diversify the curricular integration of Wetland Studies, Tropical Coastal Marine Ecosystems, and Tropical Cyclones in Climatology and Sustainable Development in basic education. Instituting these is unique for all countries in the Asia-Pacific region having small island biodiversity.
- Instituting policies on the direct involvement of science teachers in community development and extension activities. Teachers will assist local people's organizations in the planning and implementation of programs and projects about mangrove biodiversity conservation.

Since species and populations in an ecosystem will vary from year to year due to evolutionary changes, results of works on species diversity could be used in studies related to species-abundance relationships in mangals, population dynamics and growth estimation in mangrove fishes. Recommended actions offered to reduce or arrest the eventual degradation of the mangrove resources may focus on classical educational campaigns, preservation of remaining mangrove stands to be managed by schools, implementation of mangrove forest parks in schools, provisions for undertaking researches on the structure and function of mangroves and capability building initiatives for the coastal dwellers (and "mangrovellers") who will assist the schools in managing rehabilitation projects.

Science and environmental education, both formally through the schools and informally through special mangrove biodiversity conservation centers for the youth and adults are of critical importance. The need to counter the growing attention of the youth in internet gaming through educational opportunities on "cybermangroves for kids" and to provide chances for the children to experience the natural environment with their senses through hands-on learning in local mangrove areas are urgently needed. The vitality to convey to the children and youth the exciting and wonderful world of mangroves need to be refocused in countries where marine coastal areas are abundant. Moreover, non-governmental organizations and local community dwellers have significant roles in science education, both formal and informal. This can be done by carrying out the cooperative or collaborative programs and activities presented in the succeeding paragraphs.

Considering the belief that children and the youth can learn various things from their own local natural resources while they are still unconscious of the complex components and processes of mangrove biodiversity and its conservation, the following science education initiatives are hitherto suggested for science teachers in countries where mangroves and other coastal vegetation are abundant. The following activities are ongoing and some are proposed in a project called SURMABIOCON (Sustainable Resources for Mangrove Biodiversity Conservation): Connecting Children and Youth to the Dynamics of Mangroves- A Partnership and Participatory Approach (PAP). This project is presently seeking possible sponsors for funding. A visit to the mangrove ecosystem is a PAP approach when the local coastal dwellers and members of mangrove associations or direct stakeholders cooperatively work with science teachers. This approach attempts to link science teachers and coastal dwellers in terms of doing mangrove biodiversity conservation initiatives.

1. "Mangrove Watching" or "Boating Experience" in a Local Mangrove Area

This is a guided tour in a mangrove area to be assisted by the science teacher, science club officers and members of the local mangrove association or "mangrovellers". A pictorial guide about a local mangrove ecosystem is shown first to the students prior to the activity. Since the mangrovellers are assumed to be knowledgeable about the local flora and fauna, they will be considered as resource persons for topics, such as uses of mangrove plants for medicine. For example, members of Palnab-Pajo Mangrove Association in Virac and Agojo Marine Reserve Area Mangrove Association in San Andres, Catanduanes were asked by this author to discuss how the associated mangrove species, e.g. *Acanthus ebracteatus* can be used for treating gastric ailments during tryouts among high school and elementary pupils of the island.

2. Extended Classroom-Teaching in a Mangrove Replenishment or Reforestation

Project. Although this is similar to fieldwork, community-based or problem–based approach in science teaching, this extended classroom activity in a mangrove replenishment/regeneration site is a PAP approach. A strategy for this approach can be done by giving students opportunities to directly learn with their senses the concepts of an open ecosystem, plant growth, reproduction and development of *Rhizophora*. Students can interact with local coastal dweller-facilitators about such concepts related to the effects of surface and underground water circulation; and the effects of strong winds, water current, waves or tsunamis on the mangrove plants. These topics are vital to the concepts of sedimentation processes, environmental chemistry and the physiology of plants.

During a tryout among college students, the partnership of observation and comments on the growth of replanted mangrove plants in the advent of underground water circulation was discussed. When the students asked about the influences of the large-scale dynamics of tides, the science teacher facilitated the discussion. The series of visits of students to the mangrove area can generate more observation and contribute to the process of science or the scientific method of thinking.

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