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THE ACCEPTABILITY OF USING BIOREMEDIATION IN MOGPOG, MARINDUQUE, A MINED-OUT COMMUNITY IN THE PHILIPPINES

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ABSTRACT – Heavy metal contamination of soil and water were found in Barangay Capayang in Mogpog, Marinduque, Philippines after mining operations closed in 1982. Bioremediation activities to remove or neutralize hazardous substances were undertaken by UPLB scientists and the local officials since 2006. The survey of 259 households showed that bioremediation is acceptable as a solution to remove the toxic waste in water for domestic use (Z test =0.00 to 0.10). The study has also shown that the attendance to bioremediation lecture has positively changed the attitude of the attendees. The attitude scores for the 19 out of the 21 statements was significantly higher for the attendees as compared to the non-attendees. Moreover, the median acceptability scores on half of the 18 acceptability statements was also significantly higher among the lecture attendees. The focus group participants reiterate that bioremediation can lead to good health and can restore their agricultural livelihood. In addition, they have resolved not to allow future mining activities in their community. Continuous partnership among various stakeholders is recommended to sustain the bioremediation activities in the mined-out community.

Keywords: bioremediation, heavy metal contamination, mined-out community, social attitude and acceptability

INTRODUCTION

The mining industry contributed to the Philippine economy because of mineral production. Besides mineral production, the mining industry has also provided immediate employment, in fact, it increased from 130,000 workers in 1997 and reaches about 252,000 workers in 2012. This accounted for an observed 9.6 percent average annual mining workers increase. Thus, the mining industry's overall contribution to the country's total employment is believed to be low at less than one percent, although during the year 2012, it had reached its peak at 0.7 percent (Mining Industry Statistics, Mines and Geosciences Bureau 2013; DLSU.edu.ph 2014).

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In spite of being a contributor in strengthening the economy, large-scale mining has its own drawbacks in which environmental degradation is the most pronounced and disturbing. In particular, its operations have destructive impacts because of a method called open-pit mining. This method requires wiping out hectares of rainforests and agricultural lands, as well as performing deep excavations for mineral extraction, the usage of toxic heavy metals and chemicals in order to process mineral ores, and the usage of a huge amount of water. All of such processes contribute to affecting the "health, life, food security, livelihood, and a clean environment" surrounding the local people (Espiritu 2015).

It was also observed that since minerals from mines are non-renewable resources. It is expected that once minerals are exhausted, the mining operations ceased and become abandoned. Abandoned mines are the result of policy failures as well as the weak implementation of mining rules and regulation. (Amponsah-Dacosta & Mhlongo, 2015).

In fact, in the 20 abandoned mines across the country that were observed by Tetra Tech EM Inc. in 2001, indicated that the "Land and water media are impacted with chemical contaminants, which may harm human health and the aquatic, terrestrial and wild lives. Unless proper mitigation and corrective actions are undertaken, the surrounding population and receiving environment will be continuously exposed to both chemical and physical risks." This conclusion implies the imperativeness of implementing proper actions to stop the destruction to the environment of the abandoned mines. Bioremediation is one of the technologies that is being used to mitigate the effects of mining on people and communities.

Bioremediation is operationally defined in a wide array of reference. For instance, according to Fulekar et al. (2009) as cited in Singh et al. (2014), bioremediation is the use of microorganisms to hasten degradation of hazardous organic pollutants to "environmentally safe levels in soils, sediments, substances, materials and ground water". Biological remediation is devised to "either precipitate effectively immobilize inorganic pollutants such as heavy metals" (Fulekar et al. 2009 as cited in Singh et al. 2014). Bioremediation usually occurs in soil/water environment, whereby compounds are broken down into less toxic compounds and/or environmentally friendly compounds by microorganisms. Through time and constant evaluation, it is proven that the bioremediation techniques are effective and efficient for the remediation of pollutants. Most of these evaluations are technical in nature with limited appraisal on the social impact, specifically, on the attitude and acceptability of local stakeholders on technology being introduced.

Bioremediation impacts are also interestingly viewed using the perspective of social scientists. Both sociologists and political scientists have used different assessment perspectives of the social consequences of a technology. For example, sociologists equate social impact with social change by looking into changes in land use patterns, distribution of power, race and ethnic distribution. Furthermore, the sociology of technology has shown that new technologies are co-constructed (Martin 1999). This co-construction implies the inevitable link between technology and society. Whenever researchers introduce a technology, they simultaneously engage in a process of "heterogeneous social technical engineering" that includes the formation of networks regulators, new industries, re-conceptualization of many common and traditional knowledge, perceptions, and practices. Political scientists on the other hand, would emphasize the interplay of various stakeholders and their interests, and the use of power and authority in the community. Majority of the literature on the social understanding and impact of technology on society had focused on the use and abuse of technologies as well as the social responsibilities of professionals and experts (Greely 1998), financial and social resources; and increase in the size of law enforcement agencies in local communities (Burdge 1987).

According to Straub (2009), technology adoption is a complex process that entails social and development processes. In the decision process of adoption, the adopters usually construct unique yet changing perceptions like the cognitive, emotional, and contextual concerns of technology. This is one of the many reasons why several well-meaning technologies have failed because of the absence of human factor when in fact, information about the target population is as essential as the development of the technology itself. The people's attitudes and acceptability relative to the technology being developed, in this case, the application of bioremediation in heavily contaminated areas in the Philippines, as well as their relationship to their bio-physical environment need to be assessed to gain insights as to the best mechanism on motivating the potential beneficiaries to adopt the technology.

This study aims to seek answers to the following questions: What are the household characteristics of Barangay Capayang?; What are the knowledge and perceived advantages of bioremediation in the rehabilitation of their mined-out community?; Was there a change in attitude on and acceptability of the technology after the information on bioremediation was given by an expert?; and What can the forging of the participation of various stakeholders do to rehabilitate the physical damage of mining their community?.

Technology adoption is a complex process influenced by extrinsic and intrinsic factors. The extrinsic variables include characteristics of farmers, external environment, and innovation while intrinsic variables include knowledge and attitude towards the technology. It was argued that intrinsic factors influenced the knowledge and attitude of those who will be using the technology (Meijer et al 2014). Knowledge, simply defined, is information about a technology, in this case, bioremediation. In this particular study, knowledge refers to what bioremediation is and what benefits can be derived from using this technology. The power of collaboration also is an important consideration in introducing technology like bioremediation. Private-sector investors and host communities may collaborate in the diffusion of technologies to reduce the costs of technology transfer and make technology more appropriate to developing countries (Forsyth 2005).

METHODOLOGY

Marinduque was at high risk due to the presence of a considerable number of abandoned mines in the area. Heavy metal- contaminated areas such as Marinduque are called "hot spots." In addition, an area is considered high risk because of the presence of families near the mined-out site. After the stoppage of the mining operations, drinking water was heavily contaminated with heavy metals toxic waste, and some farmlands were rendered infertile due to the chemical waste from its operations (Llamado et al., 2013).

Aside from the physical hazards, the Calancan Bay which is located in the northern part of Marinduque had suffered from the heavy siltation caused by the mine tailings of Marcopper mines abandoned years ago. Aside from Calancan Bay, the Mogpog River, which is part of the locale of the study, has also experienced water contamination. This was inevitable as the river was within the impact range of the Tapian pit collapse. Similar with Calancan Bay, negative consequences were also observed among the surrounding communities of Mogpog River. One of which was the abandonment of a previously productive rice field due to heavy siltation caused by the mine tailings. To explore such effects, a study was conducted by a team from the Institute for Environmental Conservation and Research (INECAR) of Ateneo de Naga University. Result indicated, among others, was the gradual deposition of heavy metals along the soils of the Mogpog riverbanks, likewise, contaminating the plants present in the area. Despite its initial low concentration, it was foreseen that gradual deposition of heavy metals could cause further accumulation,

posing great threats to the survival of the remaining living organisms (ADNU.edu.ph 2004).

Barangay Cayapang in Mogpog Marinduque (see Figure 1) was the chosen study site since research previously conducted in the area indicated that it is heavily contaminated with metals that are attributed to the abandonment of a mining company in 1982. Mogpog is a third class municipality. The estimated terrain elevation above sea level is 90 metres. According to the 2010 census, it had a population of 33,384 people. Mogpog is politically subdivided into 37 barangays. One of these barangays is Brgy. Capayang with a total population of 1,302 persons (PSA2012).

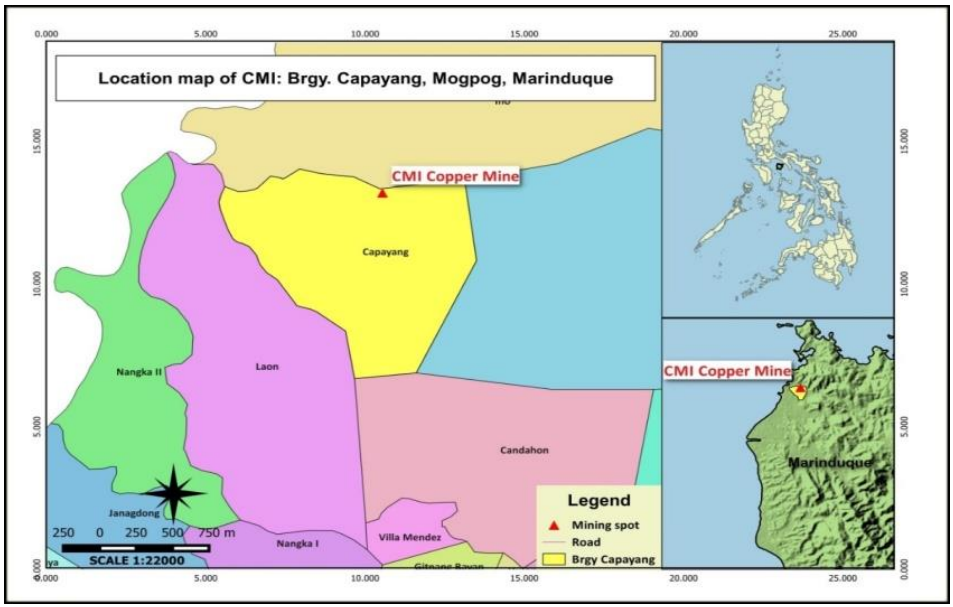

Figure 1. Study site of the research.

In 2008, 53 percent of the total population of Brgy. Capayang were below the poverty threshold according to the Marinduque Community-based Monitoring System (CBMS). About two percent (2.3%) of the population who are 15 years old and above were unemployed. About six percent of the children 6-16 years old were not attending school. Five percent did not have access to safe water supply, and 24 percent had no access to sanitary toilet facilities.

In seeking a potential alternative flora species for bioremediation, Llamado et al. (2013) conducted a study on the rehabilitation of an abandoned mining site in Mogpog, Marinduque with the use of *Jatropha curcas* and other different reforestation tree species. They found out that such "treatment enhanced the population of heavy metal-resistant rhizosphere bacteria in *Jatropha* indicative of its potential in bioremediation." Rehabilitation of abandoned mining site can be done by planting diversified plant because this would enhance rhizosphere bacterial population.

Survey and Focus Groups Discussions

Awareness, attitudes, and acceptability of bioremediation technology were determined through a survey of 259 randomly selected households. Initially, participants responded to a 29- and 20-item scale on attitude and acceptability, respectively, of the bioremediation technology as a fulfillment of the pre-test. The community was given information on bioremediation by an expert including the efficiency of this technology on absorbing toxic matters in a mining area and its benefits. The 60 respondents who attended the lecture were asked to respond to the same structured attitude scale (or post-test) to measure the differences in perceived attitude and acceptability on the importance of bioremediation. The same survey respondents were invited to participate in the Focus Groups. Two Focus Groups were formed; each consists of 15 household members. Each group was shown with photos in Figure 2. The discussion centered on the identification of areas similar to the first picture and the possible reasons for the lack of vegetation. In addition, the discussion was guided by the questions:; What did they learn from the lecture of the bioremediation expert?, and What were the bioremediation activities they have done and would they participate in activities like bioremediation to mitigate the effects of mine tailings on the farm, water sources, and air quality.

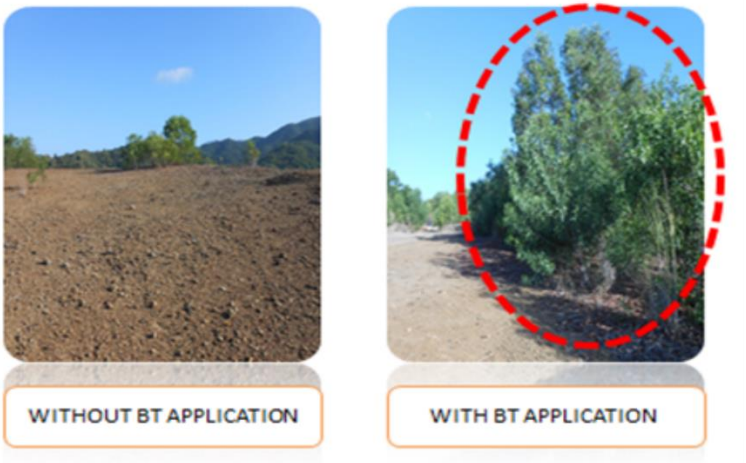

Figure 2. Photos shown to focus group participants.

Data Analysis

The total number of respondents in the first survey was 259. Percentages were computed on the following socio-economic and household variables: gender, educational attainment, household size, type of household, land ownership, occupation (before and after mining), and the indicators of level of living (household construction of materials, source of drinking water, electricity, fuel source, toilet facility and appliance). Likewise, percentages were computed on knowledge on bioremediation, perceived advantages of bioremediation, attitudes and acceptability of bioremediation.

A few months after the first survey, an expert delivered a lecture to introduce bioremediation technology and elaborate its benefits and effects to the environment. Sixty respondents randomly chosen from the total 259 respondents of the household survey participated in this lecture. After the informative lecture, all lecture participants answered the attitudes and acceptability portion of the post-test survey to determine the kind and extent of changes in their attitudes and acceptability relative with the pre-test results.

The changes in attitude of the respondents were determined by computing the difference in the median scores in the first survey (pre-test) and the second survey (post-test).

The formula used,

Standard Score,

$$z = \frac{X - \mu}{\sigma}, \text{ where}$$

μ = mean
X = score
Ơ = standard deviation

RESULTS AND DISCUSSIONS

Characteristics of Capayang Residents

Table 1 shows the distribution of the respondents' marital status by age group. Three-fourths are married (75.3%), and belong to the early adult and middle adult. The young age group are single (80%) while the older age groups are married (82.9 %for middle adult and 59.6 for late adult) The old age groups were mostly widowed (66.7%). This age distribution is similar to the Philippine population where the 15-64 consists of 62.4 percent, while those between 0-14 years comprised of 33.3 percent (PSA, 2015).

Table 1. Percentage distribution by marital status and age group, Brgy Capayang, Mogpog, Marinduque, 2014.

	Age group (in percent)					
Marital status	Young	Early adult	Middle adult	Late adult	Old	Total
Single	80	5.7	3.4	2.1	0	5.4 (14)
Married	20	78.2	82.9	59.6	33.3	75.3 (195)
Widowed	0	2.3	10.3	38.3	66.7	13.1 (34)
Live-in partners	0	10.3	0.9	0	0	3.9 (10)
Separated	0	3.4	2.6	0	0	2.3 (6)
Total	100 (5)	100 (87)	100 (117)	100 (47)	100 (3)	100 (259)

A little less than two-thirds of the respondents are female (64. 5%). Most of the respondents have high school education (40.9%) and those with elementary education (37.1%) education (see Table 2). Majority of the household size of respondents had between three to six members (64.55%), implying that most families have one to four children. Sixty-two percent of the respondents live in a nuclear-family household. Half of the respondents (51%) are using their residential lots for free.

Table 2. Socio-economic and household characteristics of respondents, Brgy. Capayang, Mogpog, Marinduque, 2014 (in percent).

Item	Percentage
Gender	
Male	35.5
Female	64.5
Total	100.0 (259)
Educational Attainment	
No formal schooling	0.4
Elementary undergraduate	15.1
Elementary graduate	22.0
High school undergraduate	18.1
High school graduate	22.8
Vocational education	3.1
College	8.5
College graduate	9.3
Postgraduate	0.8
Total	100.0 (259)
Household size	
1-2	12.7
3-4	41.7
5-6	22.8
7-8	14.3
9-10	8.5
Total	100.0 (259)
Type of household	
Nuclear family	62.2
Extended family	37.8
Total	100.0 (259)
Land ownership	
Own	47.1
Renting	1.9
Free	51.0
Total	100.0 (259)

When the mining company was in operation in Barangay Capayang, more than three-fourths of the respondents (78.8%) did not have a job, while small percentages were engaged in sales and services (7.3%) and agricultural profession (6.2%) (see Table3). This could be because some were still studying. After the mining operation had closed in 1972, more than half of those who did not have job became either a full-time housewife (32.4%) or went to sales and services (30.4%). There was an increase in the percentage of professionals, sales and services and in the agricultural profession. On the other hand, the percentage of laborers decreased (see Table 3).

Half of the respondents' houses (50.6%) are made mostly of concrete materials. More than a third of the respondent get their drinking water from natural sources like springs, rivers or streams (37.8 %) and have public sources like pumps, wells, and municipal waterworks (36.7%). Most of the respondents had electricity supply (86.1%) and have their own meter. Their primary sources of fuel for cooking are wood (48.3%) and charcoal (47.1%) as these were more economical to use compared to LPG and electricity. Majority of their toilet facility were manual flush-type (81.9%) which is common in the rural areas. Most households had at most three appliances (80.7%) This indicates that most of them could be in the lower class (49.83%) (see Table 4).

Table 3. Percentage distribution by occupation before and after the mining operation, Brgy Capayang, Mogpog, Marinduque, 2014.

Occupation after mining operation	Occupation before mining operation						
	None	House wife	Professional	Sales & Services	Laborer	Agricultural	Total
None	15.2	40	0	26.3	7.7	43.8	17.8 (46)
Housewife	32.4	0	0	10.5	0	0	26.3 (68)
Professional	5.4	0	100	0	0	0	5 (13)
Sales & Services	30.4	40	0	42.1	23.1	18.8	30.1 (78)
Laborer	1	0	0	0	7.7	0	1.16 (3)
Agricultural	15.7	20	0	21.1	61.5	37.5	19.7 (51)
Total	78.8 (204)	1.9 (5)	0.8 (2)	7.3 (19)	5 (13)	6.2 (16)	100 (259)

Table 4. Level of living of respondents, Brgy Capayang, Mogpog, Marinduque, 2014 (in percent).

Level of Living Indicators	Percentage
House construction materials	
Concrete and others	50.6
Wood and others	47.1
Other materials	2.3
Total	100.0 (259)
Source of drinking water	
Private sources	12.7
Public sources	36.7
Natural sources	37.8
Other sources	12.7
Total	100.0 (259)
Electricity	
Yes	86.1
No	13.9
Total	100.0 (259)
Fuel source	
Wood and others	48.3
Charcoal and others	47.1
LPG and others	3.9
Electricity and others	0.4
Other sources	0.4
Total	100.0 (259)
Toilet facility	
Flush	1.2
Manual flush	81.9
No own toilet	17.0
Total	100.0 (259)
Appliance	
0-1	40.5
2-3	40.2
4-5	13.5
6-7	3.9
8-9	1.9
Total	100.0 (259)

Knowledge and Perceived Advantages on Bioremediation

Bioremediation technology is a widely prevalent concept used and understood by scientists in an academic community particularly in addressing water pollution through an ecologically-sound mechanism. Although already a breakthrough technology, information and practice relative to bioremediation is lacking among the non-academic sectors such as the community in the study site which consists of members whose highest educational attainments are either primary or secondary. As such, it would be fair to assume that their grasp of technical understanding will be limited, and thus, training, seminar or any activity to capacitate them would be imperative prior to exposing them to the technology.

At the level of the individual and households, knowledge and perceptions can inhibit technology adoption. Meijer et al. (2014) reviewed the existing theories and frameworks in the adoption of agricultural innovations. They found out that innovation studies tend to focus on extrinsic factors like characteristics of adopters and the external environment in the decision-making process. The review argued knowledge, perceptions and attitude played a significant role but had been less studied. They argued that adoption of any innovation should take into consideration both extrinsic and intrinsic factors to strengthen its multi-dimensional value to its users.

Knowledge plays an important factor in the acceptability of a new technology. In this case, the barangay residents' awareness of bioremediation and its perceived advantages can affect their attitude and acceptability of bioremediation. The respondents' awareness and positive perception of the bioremediation in its capacity to rehabilitate the adverse effects of mining are associated to their likelihood to have positive attitudes and the technology will be acceptable to them.

Table 5 summarizes the result of the survey on the general knowledge of the respondents on bioremediation. Only 18 percent registered previously knowledge on bioremediation. Themes derived from their knowledge were heterogenous, but most were aware that bioremediation is about planting trees (42.31 %) while 25 percent said that it pertains to the care and preservation of the environment. There were about 5.77 percent who mentioned the use of microorganisms to absorb the toxic substance brought about by mine tailings.

Table 5. Knowledge on bioremediation technology, 259 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Response	Frequency	Percentage
	212	81.85
Yes	47	18.15
Total	259	100
Meaning of BT*		
Planting	44	42.31
Care and Preservation of the environment	26	25
Cleaning the surroundings	11	20.58
Proper disposal and segregation of wastes	8	7.69
Applying microorganism	6	5.77
Natural decomposition	3	2.88
Avoiding adverse effects of natural calamities	3	2.88
Others	3	2.88
Total	104	100

*multiple responses

In spite of their limited understanding of the knowledge about bioremediation, they provided answer to its advantages for the family and community (see Table 6). To the family, bioremediation is for flood prevention, avoidance of soil erosion, and for increasing yields. The benefits to the community are similar to the direct benefits to the family, but in addition, the community would not only enjoy higher yield but also better quality of the produce with the application of bioremediation.

Table 6. Perceived advantages of bioremediation technology, 259 respondents, Brgy Capayang, Mogpog, Marinduque, 2014.

Advantages	Family		Community	
	Frequency	Percentage	Frequency	Percentage
Prevent Flooding	84	24.42	61	21.33
Avoid Soil Erosion	82	23.84	57	19.93
Increase Yield	57	16.57	56	19.58
Increase Food Production	30	8.72	2	0.70
Better Quality of Yield	24	6.98	51	17.83
Avoid Getting Sick	17	4.94	14	4.90
Typhoon and Wind Barrier	14	4.07	12	4.20
Increase Seafood Production	13	3.78	10	3.50
Clean and fresh Air	10	2.91	12	4.20
Clean Environment	5	1.45	2	0.70
Higher rice yield	3	0.87	0	0
Livelihood	2	0.58	2	0.70
Protection against warm climate	1	0.29	4	1.40
No Answer	2	0.58	3	1.05
Total	344	99.99	286	99.99

Attitude and Acceptability of Bioremediation

Results showed that the respondents have a positive attitude towards bioremediation (Table 7). Most respondents knew that bioremediation is effective in eliminating toxic wastes from the bodies of water, from the water used in household activities, including potable water for domestic use. Likewise, most respondents said that bioremediation can help absorb chemical wastes from soil, which helps the increased presence of beneficial insects needed for farming. They also believe that it helps absorb the foul smell that resulted from the chemicals used in mining (see Table 7). These findings are consistent with the study by Page and Atkinson-Grosjean (2013) on the public acceptability of ecogenomics-enhanced bioremediation (EEB) where participants in nine community groups were interviewed in British Columbia. The respondents have positive attitudes toward EEB. However, they also expressed concerns on the possible unintended consequences of the technology.

For the respondents, the solutions of the UPLB scientists and LGU officials are acceptable. They believe that the methods used (bioremediation) can remove the heavy metal contamination from the soil and that the benefits from bioremediation are long term. Their agreement on the importance of self-initiated solutions was also high. Majority have agreed to the statement that all members of the community should participate in the activities about bioremediation. They expect that the barangay officials should take the lead in these activities. This finding is not consistent with the above-mentioned study of Page and Atkinson-Grosjean (2013) where the participants have low level of trust in authorities.

For the residents of Barangay Capayang, they see the opportunity in these activities to improve the level of cooperation in the community. There is overwhelming willingness to attend meetings about bioremediation. For most respondents, carrying out these bioremediation activities is within their capacity. However, for some respondents, the meetings about bioremediation require time and may conflict with their routinely activities which are their chief priority.

Table 7. Percentage distribution on attitudes and acceptability toward bioremediation, 259 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	SA	A	D	SD	N/A
			Percentage		
Ang mga bioremediation technologies ay mabisa sa pagtanggal ng mga kontaminasyon na likha ng pagmimina. (Bioremediation technologies are effective in eliminating toxic wastes resulting from mining).	27.8	59.9	7.6	3.8	0
Ang mga bioremediation technologies ay walang kabutihang maidudulot. (There is no benefit from using bioremediation technologies)	2.7	15.4	**59.1**	22.8	0
Ang mga bioremediation technologies ay sumisipsip ng mga kemikal na nasa tubig.(Bioremediation technologies absorb toxic wastes in bodies of water)	21.2	**67.6**	9.3	1.9	0
Ang mga bioremediation technologies ay sumisipsip ng mga kemikal na nasa lupa (Bioremediation technologies absorb toxic wastes in the soil)	20.1	**67.6**	10.4	1.9	0
Ang mga bioremediation technologies ay sumisipsip ng mga mababahong amoy. (Bioremediation technologies absorb foul odor)	18.5	**66**	13.5	1.9	0
Ang mga bioremediation technologies ay nakakatulong sa pagpapayaman ng mga iba't-ibang uri ng kaibigang kulisap sa komunidad. (Bioremediation technologies help increase the population of beneficial insects)	20.1	**59.1**	17.8	3.1	0
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng lupa. (Bioremediation technologies can help improve the condition of the soil)	24.3	**69.5**	3.5	2.7	0
Ang mga bioremediation technologies ay nakaktulong sa pagbuti ng kalidad ng inuming tubig. (Bioremediation technologies can help improve the condition of drinking water)	22.8	**66.8**	7.7	2.7	0

SA-Strongly Agree; A-Agree; D-Disagree; SD-Strongly Disagree; N/A-No Answer

Change in the Attitude on and Acceptability of Bioremediation after the Bioremediation Lecture

The changes in attitude and acceptability of bioremediation performed after the bioremediation lecture were determined by computing the difference in the median scores of the respondents in the first survey (pre-test) and the second survey (post-test). Results showed that there is a significant increase in the median scores on statements pertaining to the bioremediation as a worthwhile activity and as an effective way of eliminating toxic materials in water and soil (see Table 8). In particular, respondents view the technology as a way to eliminate toxic materials from the bodies of water, and even from the water used for the household, especially drinking water. These findings are not similar to the survey conducted by

Kocher et.al. (2002) in California who found that the participants preferred excavation of contaminated soil over the use of bioremediation.

There is also a significant change in the respondent's attitude towards bioremediation as an opportunity to increase the community's participation and cooperation in any bioremediation-related planned activities, and for the barangay officials to assume leadership in such activities. Moreover, there is a significant increase in scores on the statements that the community members should attend the meetings and activities related to bioremediation activities. The only statement that showed no significant change in the median scores is that there is no benefit from using the bioremediation technologies. This further supports the respondents' positive attitudes on the benefits from implementing bioremediation. Another statement that showed no significant change in the median score is that bioremediation helps increase the population of beneficial insects. This could be because the respondents had already recognized the importance of bioremediation in increasing beneficial insect population even before the lecture, hence, not much dramatic change in their knowledge was recorded.

Since most of the respondents are from farming households, there was a significant increase in the median scores on items related to farming, A high median score is observed on statements related to their willingness to cooperate on bioremediation. This is anchored on the premise that the technology can eliminate toxic wastes in the soil (0.005) and help in increasing the population of beneficial insects (0.009) (Table 9). They also recognized the importance of bioremediation in eliminating toxic wastes from bodies of water. Although the lecture discussed the importance of bioremediation in eliminating toxic wastes in soil, water, and air, the respondents remembered topics which are related to their source of livelihood. This is attributable to the primacy of this kind of information to their traditional economic activity.

Since potable water is an important basic need, bioremediation became more acceptable (0.007) to the respondents because of its contribution in improving water quality used for home consumption (Table 9). Moreover, there is a significant decrease in the scores on statements that they will not cooperate in activities on bioremediation because these are difficult to carry out, that attending meeting on bioremediation will interrupt their work, and that because other people are doing them.

Forging Partnership and Commitment of the Community on Bioremediation Activities

The community consists of various stakeholders. These stakeholders' cooperation and commitment are needed for the success of any action program to be implemented especially if within their community. The results of the survey show the commitment of the stakeholders in Brgy. Capayang (see Table 10). Although there are several activities that were done by the different stakeholders, the most common engagement is tree planting. In addition, the stakeholders are also concerned on cleaning the environment. The Marinduque Council for Environmental Concerns (MACEC) specifically gather the community members to inform them about the disadvantage of mining in the community.

In the Focus Group, the participants were probed with the possible solutions of getting rid of the pollutants that destroyed their surroundings. The following were the participants' responses. First, each family should plant trees. One participant suggested that "*Ano kaya kung isang bahay ay limang puno*?" (What if we plant five trees per household?). In addition to planting trees, a participant suggested the application of organic fertilizers to trees and crops. Furthermore, some participants suggested planting of trees in the abandoned mining sites and avoiding tree cutting.

Clean up drives near the river was also suggested as a solution and this activity must be initiated by the community residents. Some participants said they will stop burning dried and falling leaves, instead

they will place it to designated compost pit per sitio. According to the participant, *"Dati po sinusunog pero ngayon po pinagbabawal na sa 'min. Naglagay po kami ng butas para dun na lamang itatambak. Nabubulok naman po. Pinagsasama ko po ang ang mga nabubulok*" (In the past, we burned dry leaves, but now it is not allowed anymore. We made a pit where we can store biodegradable materials).

Table 8. Differences in median scores of attitudes on bioremediation technologies before and after the lecture, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ang mga bioremediation technologies ay kapakipakinabang. (Bioremediation technologies are worthwhile activities)	3.00	0.646	4.00	0.623	-3.969	0.000 **
Ang mga bioremediation technologies ay mabisa sa pagtanggal ng mga kontaminasyon na likha ng pagmimina. (Bioremediation technologies are effective in eliminating toxic wastes resulting from mining)	3.00	0.651	4.00	0.584	-4.733	0.000 **
Ang mga bioremediation technologies ay walang kabutihang maidudulot. (There is no benefit from using bioremediation technologies)	2.00	0.676	2.00	1.208	-0.158	0.874 ns
Ang mga bioremediation technologies ay sumisipsip ng mga kemikal na nasa tubig. (Bioremediation technologies absorb toxic wastes in bodies of water	3.00	0.571	4.00	0.734	-2.874	0.000 **
Ang mga bioremediation technologies ay sumisipsip ng mga kemikal na nasa lupa. (Bioremediation technologies absorb toxic wastes in the soil)	3.00	0.640	4.00	0.733	-4.066	0.000 **
Ang mga bioremediation technologies ay sumisipsip ng mga mababahong amoy. (Bioremediation technologies absorb foul odor)	3.00	0.623	4.00	0.869	-2.874	0.004 **
Ang mga bioremediation technologies ay nakakatulong sa pagpapayaman ng mga iba't-ibang uri ng kaibigang kulisap sa komunidad. (Bioremediation technologies help increase the population of beneficial insects.)	3.00	0.686	3.00	1.217	.000	1.00 ns
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng inuming tubig. (Bioremediation technologies can help improve the quality of drinking water.)	3.00	0.691	4.00	0.645	-4.564	0.000 **

Table 8 (Continued). Differences in median scores of attitudes on bioremediation technologies before and after the lecture, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng lupa. (Bioremediation technologies can help improve the condition of the soil.)	3.00	0.691	4.00	0.632	-3.830	0.000 **
Ang mga bioremediation technologies a nakakatulong sa pagbuti ng kalidad ng tubig na ginagamit sa bahay. (Bioremediation technologies help improve the quality of water used in the households.)	3.00	0.576	4.00	0.662	-3.133	0.002 **
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng ilog/dagat. (Bioremediation technologies help improve the quality of bodies of water.	3.00	0.606	4.00	0.555	-4.347	0.000 **
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng hangin. (Bioremediation technologies help improve the quality of air.)	3.00	0.607	4.00	1.106	-2.433	0.015 *
Ang mga solusyon na galing sa Siyentipiko ay mahalaga sa pagtatanggal ng mga kontaminasyon na dulot ng pagmimina. (The solutions provided by the scientists are important in helping remove contamination resulting from mining.	3.00	0.524	4.00	1.140	-3.043	0.002 **
Ang mga solusyon na galing sa Opisyal ng Barangay ay mahalaga sa pagtatanggal ng mga kontaminasyon na dulot ng pagmimina. (The solutions provided by the barangay officials are important in helping remove contamination resulting from mining.)	3.00	0.500	4.00	1.140	-3.320	0.001 **
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng lupa. (Bioremediation technologies can help improve the condition of the soil.)	3.00	0.691	4.00	0.632	-3.830	0.000 **
Ang mga bioremediation technologies a nakakatulong sa pagbuti ng kalidad ng tubig na ginagamit sa bahay. (Bioremediation technologies help improve the quality of water used in the households.)	3.00	0.576	4.00	0.662	-3.133	0.002 **

Table 8 (Continued). Differences in median scores of attitudes on bioremediation technologies before and after the lecture, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng ilog/dagat. (Bioremediation technologies help improve the quality of bodies of water.)	3.00	0.606	4.00	0.555	-4.347	0.000 **
Ang mga bioremediation technologies ay nakakatulong sa pagbuti ng kalidad ng hangin. (Bioremediation technologies help improve the quality of air.)	3.00	0.607	4.00	1.106	-2.433	0.015 *
Ang mga solusyon na galing sa Siyentipiko ay mahalaga sa pagtatanggal ng mga kontaminasyon na dulot ng pagmimina. (The solutions provided by the scientists are important in helping remove contamination resulting from mining.)	3.00	0.524	4.00	1.140	-3.043	0.002 **

* Significant at 5% ** Significant at 1%

Table 9. Differences in median scores of acceptability of bioremediation technologies before and after the lecture, 60 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ako ay interesadong dumalo sa mga pagpupulong ukol sa bioremediation technolog (I am interested in attending meetings related to bioremediation technology,)	3.00	0.515	4.00	1.094	-2.089	0.037*
Ako ay makikiisa sa mga gawain ukol sa bioremediation technology dahil ito ay kapakipakinabang. (I will cooperate in activities on bioremediation technology because they are beneficial.)	3.00	0.534	4.00	1.212	-.548	0.584 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay mabisa sa pagtanggal ng mga kontaminasyon likha ng pagmimina. (I will cooperate in activities on bioremediation technology because they are effective in removing contamination caused by mining.)	3.00	3.846	4.00	1.267	-.183	0.855 ns

Table 9 (Continued). Differences in median scores of acceptability of bioremediation technologies before and after the lecture, 60 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay sumisipsip ng kemikal na nasa tubig. (I will cooperate in activities on bioremediation technology because they will help in absorbing toxic wastes in bodies of water.)	3.00	0.524	4.00	1.166	-1.973	0.049 *
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay sumisipsip ng kemikal na nasa lupa. (I will cooperate in activities on bioremediation technology because they will help in absorbing toxic wastes in the soil)	3.00	0.541	4.00	1.190	-1.500	0.134 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagpapayaman ng mga iba't-ibang uri ng kaibigang kulisap. (I will cooperate in activities on bioremediation technology because they will help increase the population of beneficial insects.)	3.00	0.710	4.00	1.197	-2.630	0.009 **
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagbuti ng kalidad ng lupa. (I will cooperate in activities on bioremediation technology because they will help improve the condition of the soil)	3.00	0.555	4.00	1.015	-2.785	0.005 **
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagbuti ng kalidad ng inuming tubig. (I will cooperate in activities on bioremediation technology because they will help improve the condition of the water).	3.00	0.567	4.00	1.202	-1.393	0.164 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagbuti ng kalidad ng tubig na ginagamit sa bahay. (I will cooperate in activities on bioremediation technology because they will help improve the quality of drinking water.)	3.00	0.651	4.00	1.197	-2.704	0.007 **

Table 9 (Continued). Differences in median scores of acceptability of bioremediation technologies before and after the lecture, 60 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagbuti ng kalidad ng ilog/dagat. (I will cooperate in activities on bioremediation technology because they will help improve the quality of bodies of water.)	3.00	0.647	4.00	1.197	-1.945	0.052 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagbuti ng kalidad ng hangin. (I will cooperate in activities on bioremediation technology because they will help improve the quality of air.)	3.00	0.593	4.00	1.191	-1.886	0.059 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay nakakatulong sa pagpapabuti ng kalusugan. (I will cooperate in activities on bioremediation technology because they will help in improving health.)	3.00	0.660	4.00	1.250	-1.044	0.296 ns
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay sumisipsip ng kemikal na nasa tubig. (I will cooperate in activities on bioremediation technology because they will help in absorbing toxic wastes in bodies of water.)	3.00	0.596	4.00	1.200	-2.758	0.006 **
Ako ay makikiisa sa mga gawain ukol sa mga bioremediation technologies dahil ito ay madaling isagawa. (I will cooperate in activities on bioremediation technology because they are easy to carry out.)	3.00	0.486	4.00	1.274	-1.543	0.123 ns
Ako ay naaabala kapag dumadalo sa mga pagpupulong ukol sa bioremediation technologies. (Attending meeting on bioremediation technologies will mean interruption of my work.)	2.00	0.596	1.5	.938	-2.298	0.022 *

Table 9 (Continued). Differences in median scores of acceptability of bioremediation technologies before and after the lecture, 60 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014.

Statement	Pre-Test		Post-Test		Z	Asymp. Sig. (2-tailed)
	M	SD	M	SD		
Ako ay hindi makikiisa sa mga gawain ukol sa mga bioremediation technologies sapagkat ito ay walang pakinabang. (I will not cooperate in activities on bioremediation technology because they are not beneficial.)	2.00	0.516	1.00	.747	-1.833	0.067 ns
Ako ay hindi makikiisa sa mga gawain ukol sa mga bioremediation technologies sapagkat ito ay mahirap isagawa. (I will not cooperate in activities on bioremediation technology because they are difficult to carry out.)	2.00	0.516	1.00	.769	-2.437	0.015 *
Ako ay hindi makikiisa sa mga gawain ukol sa mga bioremediation technologies sapagkat ito ay mayroon ng ibang gumagawa. (I will not cooperate in activities on bioremediation technology because there are already other people doing them.)	2.00	0.633	1.00	.769	-2.959	0.003 **

* Significant at 5% ** Significant at 1%

Table 10. Activities Done on Bioremediation, 259 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014 .

Ginagawa (activities)	Stakeholders											
	Local Gov't Units		Gov't Agencies		MACEC		Local Residents		NGO		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
Tree Planting	166	56.27	19	45.24	15	33.33	59	63.44	2	66.67	261	54.60
Cleaning the Environment	34	11.53	10	23.81	4	8.89	17	18.28	1	33.33	66	13.81
Campaigning Against Mining	4	1.36		0.00	4	8.89	1	1.08		0.00	9	1.88
Holding Meetings Against Mining	24	8.14	3	7.14	7	15.56		0.00		0.00	34	7.11
Dredging	5	1.69		0.00	2	4.44	1	1.08		0.00	8	1.67
Making Canals	3	1.02		0.00		0.00		0.00		0.00	3	0.63
Joining Rallies Against Mining	2	0.68		0.00	4	8.89		0.00		0.00	6	1.26
Banning Logging	9	3.05	3	7.14	1	2.22	1	1.08		0.00	14	2.93

Table 10 (Continued). Activities Done on Bioremediation, 259 respondents, Brgy. Capayang, Mogpog, Marinduque, 2014 .

Ginagawa (activities)	Stakeholders											
	Local Gov't Units		Gov't Agencies		MACEC		Local Residents		NGO		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
Sand Bagging	8	2.71	2	4.76		0.00	1	1.08		0.00	11	2.30
Disagreeing Against Mining	5	1.69		0.00	1	2.22	4	4.30		0.00	10	2.09
Inform People About Mining	3	1.02		0.00	1	2.22	2	2.15		0.00	6	1.26
Pagtutol/Pag-hadlang/Pagpigil sa Minahan	17	5.76	2	4.76	4	8.89	7	7.53		0.00	30	6.28
Petition to Stop Mining	11	3.73	2	4.76	2	4.44		0.00		0.00	15	3.14
Making Surveys on the Residents About the Mining	4	1.36	1	2.38		0.00		0.00		0.00	5	1.05
Total	295	61.72	42	8.79	45	9.41	93	19.46	3	0.63	478	100.00

Another participant said that garbage should be properly segregated into biodegradable and non-biodegradable; the biodegradable will be buried to fertilize the soil in their backyards. The participant said, *"Ako po talaga ay inaayos ko nang inaayos ang basura namin. One time, kinukuha naman nila.*" (I always manage our wastes. Waste officers collect them). Another participant added "*Yung hindi kinukuha, naseparate lang ang nabubulok at hindi nabubulok*" (For those that are not collected, the biodegradable and non-biodegradable are just being segregated). Some participants promised to stop the use of plastic bags. They also specifically cited stopping their practice of using plastic as a fire source in burning dried and fallen leaves.

Also, the facilitators encouraged the participants to prepare compost that they could use to plant trees in the designated area of the dump site. They are persuaded to have at least one representative per family to take part in the tree planting and in applying bioremediation on the site. As of interview date, there are 311 households in Brgy. Capayang. A representative of each family was assigned to bring one sack of compost to the site.

Participants were asked why even the simple recovery measures like making compost, i.e. burying biodegradable wastes in soil that could serve as fertilizer and not burning plastics, were not practiced even though they were already informed in the past that those measures could help them improve their surroundings from the damage brought about by mining. The participants gave the following reasons: due to laziness; lack of discipline; Filipinos tend to be hard-headed; and lack of awareness about the deteriorating condition of the environment like the depletion of the ozone layer. Some of the participants mentioned: "*Tamad po*"; "*Ma'am wala na po disiplina ang mga Pilipino,*" and *"Matigas ang ulo*" (They are lazy; Filipinos are undisciplined; They are disobedient). Some participants observed that there are some community residents who are still cutting trees that have grown from the experiment, a problem the

participants should address. Thus, they encouraged one another to be vigilant. If there are violators catch red-handed, they should reprimand the person. One participant said: *"Sana magkaroon ng concern lahat na kapag nakakita ng mamumutol, sawayin*" (I hope everyone will be concerned especially about the logging practice so that when they see people cutting down trees, they will stop them). In addition, government agencies should continuously monitor the areas for individuals engaged in cutting trees in the barangay. According to one participant, "*…dapat po ay maglagay ng parusa tungkol sa paglabag ng mga namumutol ng punong itinanatanim*…" (…there should be penalties for those who illegally cut trees…).

It was emphasized that bioremediation cannot be done by the government and local authorities alone. There should be cooperation from the community residents. They have made a commitment to help in the said activities. However, one participant suggested that bioremediation activities should be done on weekends because they have work during weekdays.

Residents will not allow future mining activities

The participants said that they will not allow mining activities in the barangay. One participant said that "No to mining na po talaga ang Capayang" (The Capayang community is really against mining now). They added that mining had adverse effects to the environment even after the operations ended a long time ago. One participant said: *"kalikasan po ang nasisira. Walang naidudulot na maganda*" (The environment is destroyed. It does not result to anything good).

The community is slowly recovering from the harmful effects of mine tailings

In 2006, the UPLB used microorganism to facilitate the rehabilitation of an area exposed to mine tailings. Employing bioremediation, given time, could bring back the good condition of air, land, and water and would help the residents of Brgy. Capayang restore back their livelihood namely, farming and fishing.

Furthermore, the participants were asked if they remember anything from the experiment. Most of the FG participants showed a high recollection level when referring to the experiment and shared the process: "*Nagtanim sila. Bago po nagtanim, nagpatubo muna sila mula sa buto. Pagkatapos inilagay sa parang maliit na bag. Pinapatubo po. Nung tumubo na siya, tinanim na po doon…may nilagay po sila na nasa bag. Kumabaga nag experiment sila halimbawa ay alin ang natubo sa ganitong abono. Para malaman po talaga"* (They planted seeds first, then put them in a small bag. It started to grow. When it grew up into seedlings, they planted it in the soil. They applied materials from bags. It was like an experiment. They tested the appropriate plants growing using different fertilizers.).

The participants were asked to identify the place of a set of pictures shown to them. One picture showed a barren, rocky and very dry land and the other picture showed a grassy land with some trees planted on it. The participants identified the pictures to be the dump site of the mine tailings of CMI. Other places were mentioned also by the participants to be in the same condition as that of the pictures showing hot, rocky and very dry land. Before mining, they mentioned that these places were planted with coconut trees, palay, and vegetables. A general feeling of gloominess were felt by the participants after realizing what had happened to their land that previously gave them a regular source of livelihood and income.

The participants identified that a lot of areas in the upper portion of Barangay Capayang have not recovered from the effects of the mine tailings. One participant commented, "*Maraming kemikal ang lupa*" (There are many chemicals in the soil) and another participant reiterated this point by saying "*malawak pa po. Kumbaga ay mas marami pa pong ganyan*" (The affected area is wider. There are more areas with

the same adverse situation). These areas are on the upper portions of Barangay Capayang, specifically in Sitio Embargo, Ilaya and Paulong, and areas near the *"pataý na lawa*." They also recalled that the land was so hot it was like a desert. According to one participant, "*Parang disyerto. Tuyo tapos, Ma'am, parang walang mababuhay na halaman*" (It is like a dessert for being dry. It seems like no plant will grow on it).

The participants believed that the dump site of the mine tailings could not be restored and be made fertile again because, as the participants said, some tried to planting but to no avail because they only withered. According to them, any kind of plants and trees cannot survive because of the condition of the soil. They are resigned to the idea that the land could not be used for planting or farming again. One participant said, "*Kasi 80s pa, ganito na, 2015 ganito pa din*" (This had been the situation since 80s. It is now 2015 and there is no change). Another participant added to this observation by saying "*May nagtatanim ng niyog, pero namamatay*" (Some planted coconut, but many died).

But as the pictures were shown to the participants, they were enlightened that the place could be restored again through the use of bioremediation. Another picture was shown to the participants where one part is very dry and the other half shows growing trees. According to the researchers, they applied bioremediation on one-half part of the land where trees are growing and did not do anything on the other half. They started doing bioremediation on the place since 2006. Since then, the hazardous impact of copper thrown on the site was reduced. Some of the participants have gone into the site and they said that the micro-temperature was cool; the humidity has lessened. It was described now as a forested area because of the trees and other plants that have continued to grow and thrived in the place. One participant explained the changes: "*Unti-unti na pong natatanggal yung mga kemikal. Lumamig na po ang singaw. Mahangin na"* (The chemicals are continuously decreasing. The micro-temperature becomes colder).

Another participant said: *"Malamig na ang simoy ng hangin. Gubat na"* (The breeze are becoming cooler. There are more trees). Another participant added: "*Dati po ay mukha siyang disyerto para pong ayaw tubuan ng tanim. Hindi siya mabuhay. Ngayon naman po ay may damo na. Tapos yung mga itinanim na punongkahoy ay nabuhay na, yung mga itinanim din na bungang kahoy"* (In the past, the place looked like a dessert. It seemed like no plant could grow on it. At present, there are already weeds growing. The trees and root crops being planted already grow.).

Many participants observed that the areas affected by mine tailings in the barangay have slowly recovered because of the trees planted. The trees planted are mahogany (*Sweitenia macrophylla*), acacia (*Samania saman*), gmelina (*Gmelina arborea*), tuba tuba (*Jatropha curcas)* and narra (*Pterocarpus indicus*). One participant said, "…*sa karamihan po ay yung pagtatanim ng puno [and nakatulong]*" (Planting trees helped the most). Another participant added, "*Tulad po sa tubigan noon, kaunti ang ani noon. Ngayon ay dumami na. Sa palagay ko po ay dahil yun sa mga nalalaglag na mga dahon ng puno na nagiging abono*" (In the past, there was low volume of produce in the rice fields. At present, the yield gets higher. This can be caused by the falling leaves from trees which fertilize the rice field).

The participants observed that fishes and other life forms in the water are present. However, they have noticed that it took a long time before they were seen again. One person mentioned "*Ang tagal bago nagkaroon [ng isda]*" (It took a long time before fishes are seen again), in which another participant said that "*matagal po. Baka mahigit pa sa sampung tao*n" (It took a long time, about ten years). In addition, they said that there are also shells and fishes, a sign that the coral reefs are in good condition. One participant said, "*May mga nahuhuli na shells…Siguro po ay dahil okay na ang coral reefs sa ilalim po kasi once na mag unti na daw ang isda, sira na ang coral reefs. Iyon po ay dun nangingitlog ang isda, syempre dadami na ang mga isda…*"(Shells can already be harvested. Maybe this is because the coral

reefs in the deep have recovered. The decrease in fish number speaks a lot about the destruction of the coral reefs. Since the fishes can now lay eggs in the coral reefs, they increase in number).

The participants were happy when the operations of the CMI stopped because they observed that the condition of the soil was recovering from the effects of the mine tailings. One participant said, "*Masaya po kasi nawala na po yung chemicals, tumubo na po ang mga tanim. Nakakapagtanim na po*" (We are happy because the chemicals are dissipitated. The crops already grow. We can already plant). The areas that were slowly recovering from the effects of the mine tailings are in the upper portion of the barangays near the location of Barangay High School, Sitio Ulong.

SUMMARY, CONCLUSION AND RECOMMENDATION

The 259 Capayang residents whose parents have experienced the operation of mining in their community were surveyed on their attitudes and acceptance to bioremediation as a means to rehabilitate their abandoned mining community. Few or about 19 percent of them earned college education. Half of them enjoyed free house rental and another half of them own houses made of concrete materials. Drinking water is coming from public artesian wells and spring water. The respondents, unlike their parents, have not worked in the mining company. Most of their work is classified under sales and services. Only 20 percent are doing agricultural work. These social and economic characteristics of the households are indicative of their lower-middle socio-economic status. The knowledge and perceived advantage from bioremediation are low but positive which shows that only a few knew about it. They know that bioremediation can eliminate the toxic waste that pollutes their community. A significant change in their attitude and acceptability from low positive to high positive was noted after attending a lecture on bioremediation. It was also established by the study that both the lecture and focus group have helped in increasing the positive attitude on bioremediation because of the information exchange facilitated, particularly on its benefits to the people, community, and the environment. In addition, the bioremediation team of experts who regularly visited Barangay Capayang to monitor the planted areas were also responsible for the increase of knowledge and positive attitude of the community residents on the benefits of bioremediation. The households are more committed to continue supporting bioremediation-related activities.

For the sustained activities on bioremediation, it will, however, require understanding and forging a partnership between and among various stakeholders like scientists and community residents. Even if the households in Barangay Capayang have a very positive attitude and acceptability toward employing bioremediation like planting of reforestation species, they may not adopt it, if the community like the government officials is not supportive of the program. In the case of Barangay Capayang, the bioremediation team from UPLB has been working with the mayor of Mogpog and with the barangay captain of Capayang for 7 years. They have forged collaboration with these officials who in turn have provided the team support for planting reforestation tree species like *jathropha* in the abandoned mining sites. Thus, the households' positive attitudes is complemented with the strong support from the barangay officials. The study strengthens the notion that the academe, national and government agencies and community residents should collaborate in reducing the cost of technology transfer and making technology an advantage to the affected community. Collaboration also builds trusts and accountability among partners, elements that are integral in rolling out an effective technology addressing an environmental dilemma.

STATEMENT OF AUTHORSHIP

G.M. Nelson conceptualized the research. She lead her co-authors in the data collection, data analysis and in writing the manuscript. G.A. Abrigo did most of the literature search and the development of the survey questionnaire. She assisted in the data collection, data analysis of the data, and formatting the manuscript. A.K. Raymundo was the resource person or the expert for the bioremediation lecture. She assisted in the data collection and editing of the manuscript.

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