ECONOMY AND ENVIRONMENT PROGRAM FOR SOUTHEAST ASIA

Estimation of Environmental Damages from Mining Pollution: The Marinduque Island Mining Accident

Ma. Eugenia Bennagen

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Ma. Eugenia Bennagen*

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1.0 INTRODUCTION AND RATIONALE

Pollution, in general, can cause damages on natural resource systems which provide valuable though unpriced services to society. Oftentimes, the harmful effects of pollution are not considered by the polluter in decision-making, thus creating excessive environmental externalities. To estimate the externalities generated by pollution, it is necessary to develop economic measures of values of the environmental and resource services provided by the affected resource systems. The estimation process is undertaken primarily to provide inputs to the information base supporting public resource and environmental management decisions (Freeman 1993). One of these decisions that is of primary relevance to this study has to do with determining the natural resource damage liability of responsible parties in pollution cases, which can be used as basis for damage compensation to affected parties.

Mining pollution has historically been a major source of degradation of natural resource systems such as river, coastal, and air (USEPA 1995). For this reason, mining, as an economic activity, is subject to major environmental regulations worldwide, including the Philippines.[1] Unfortunately, the current information on mining externalities is insufficient to be useful for policy setting. This study was undertaken partly to partly fill this information gap, particularly in the development of policy instruments which require information on social costs of mining, and partly to assist in the formulation of guidelines on damage assessment and compensation for the mining sector. A case study of an accident-induced mining pollution was implemented.

2.0 BACKGROUND ON THE MARINDUQUE ISLAND MINING ACCIDENT AND THE BOAC RIVER

2.1 The Mining Accident

Marinduque Island is located about 170 kilometers south of Manila. It has a total land area of 959.2 km^2 (see Map 1). Administratively, it is one of 11 provinces of Region IV or the Southern Luzon region. The provincial population in 1995 was 199,910, with almost one-fourth (44,609) of the population residing in Boac, the provincial capital.

The Marcopper Mining Corporation (MMC) had been engaged in copper open-pit mining in the municipality of Sta. Cruz, Marinduque since the early 1970s. When the mining operation moved from the Mt. Tapian to the San Antonio mine site in 1989,

[1] The Philippine mining sector, under Republic Act 7942 and DENR Administrative Order No. 96-40, is required to set up a Contingent Liability and Rehabilitation Fund (CLRF) for the purpose of providing compensation for damages and rehabilitation for any adverse effect a mining activity may cause to the environment. See Section 8.0 for a discussion on government liability and compensation policies.

the drainage tunnel in the Tapian Pit was plugged with concrete so the pit could serve as disposal pond for the mine tailings. In August 1995, seepage was discovered in the drainage tunnel, which consequently ruptured on 24 March 1996, discharging mine tailings into the Makulapnit-Boac River system (henceforth referred to as Boac River), initially at a rate of 5-10 cubic meters per second (see Map 2).

The incident resulted in the release and deposition of some 1.6 million cubic meters of tailings along the 27-km span of the river system and the coastal areas near the river mouth west of the island-province. The impact on the river ecosystem was extensive. The devastating effects of the pollution on the river and coastal ecosystems were of such magnitude that a UN assessment mission declared the accident an environmental disaster (UNDP 1996). Boac River was left virtually dead. The onrush of tailings downstream displaced the river water, which in turn flooded low-lying areas, destroying crop farms and vegetable gardens along the banks and clogging the irrigation waterways to ricefields. Road sections straddling the river were damaged, temporarily isolating some barangays (villages) and affecting trade and access to services. All these impacts adversely affected the local residents in Boac whose livelihood activities were river-dependent.

2.2 The Boac River

The Boac River is a major river system in Marinduque and has traditionally been used for a variety of purposes by the population residing in towns along the river. The tailings spill not only had a significant visual impact on the quality of the river, but also resulted in the total loss of the river-based sources of livelihood as well as of other non-economic uses such as recreation.

During its pre-release condition, the Boac River was an important source of subsistence food for the local population such as fish, shrimps, and snails.[2] Some of the local population engaged in river fishing as a secondary occupation. A significant amount of vegetables was being grown along the river banks, both for commercial sale and subsistence consumption. Another important source of household income from the river was its use for commercial laundry services. Some of the local population also engaged in gravel and sand quarrying in the river banks. The river was also a transport route used to haul agricultural crops upstream to the Boac town market.

The river's nonmarket uses included being a source of recreational opportunities for the local residents, especially children. Some of these activities included swimming, fishing, strolling along the river banks, and picnicking. The river has also been used as a receptacle of both industry and household wastes. Other household uses of the river included bathing, washing clothes, work implements and dishes, watering gardens, and maintenance of livestock.

[2] The pre-spill resource assessment of the Boac River conducted through a household survey and interview of key informants did not indicate a declining trend in the fish catch levels over the years until the accident happened. However, the fishers interviewed indicated that recurring pollution of the river occurred during rainy seasons which they suspected was primarily caused by mine tailings from the mining project.

3.0 RESEARCH PROBLEM, OBJECTIVES, AND CONCEPTUAL FRAMEWORK

3.1 Research Problem and Objectives of the Study

The study focused on the estimation of environmental damages generated by mining pollution on a natural resource system. The natural resource system examined was a river polluted by a major mine tailings spill accident. The accident left the river downstream biologically dead, while some stretches of the river upstream were not affected by the pollution. Damage to the nearby coastal resource system was also examined.

The specific objectives were:

1) to generate primary data on environmental damages from an accident-induced mining pollution;
2) to apply economic valuation techniques in estimating the externalities from mining activities; and
3) to review and refine, as necessary, existing government guidelines on damage assessment and compensation from mining pollution.

3.2 Conceptual Framework

The economic value of a resource-environmental system is the sum of the discounted present values of the flows of all of the services from the natural system. Economic values are values that reflect an individual's welfare, which depends on the consumption of both private goods and nonmarket goods and service flows from resource-environment systems such as health, visual amenities, and recreation. These values are expressed in measures of willingness to pay or willingness to accept compensation. (Freeman 1993). Asset valuation theory provides the framework and principles for estimating these changes, which basically involves estimating net revenues or rent from the use of the natural asset. The year-to-year changes in the net revenues or rent from the use of the natural asset provides a measure of the changes in the value of the asset.[3]

A damage assessment of a resource-environmental system necessarily involves the measurement of changes in economic values of the flows of resource and environmental services injured by an event such as a pollution accident. While some of the service flows of the resource-environmental systems are linked directly or indirectly to markets, many others are not properly regulated by markets because of externalities and their public good characteristics. The need to measure economic values of environmental services arises from this failure of the market to allocate and price these services correctly (Freeman 1993).

Natural resource damage assessment (NRDA) is the process of identifying and measuring damages to natural resource systems for the purpose of compensating society for reductions in the value of natural assets that occur from the actions of others (Martin 1994). NRDA has been a recent undertaking in countries where legislation on natural resource damage liability exists and is primarily undertaken to

[3] As discussed in the following section, the study estimated changes in productivity as an approximation of net revenues or rent. Then, these changes were translated into a measure of damage in terms of foregone income.

establish the extent of damage liability of the responsible parties.[4] Environmental economics is seen to play an increasingly important and extended role in NRDA, specifically in the area of nonmarket valuation (Federal Register 1992).

Assessment of damage involving the release of hazardous substances to the environment follows three basic steps, namely: injury determination, quantification of effects, and damage determination (Dunford 1992). Injury determination links the injury to the release; quantification of effects determines in physical terms the reduction in natural resources services; and damage determination involves valuing the injury in monetary terms.

The application of the total economic value (TEV) concept as a valuation framework is a useful start in the third step of an NRDA, i.e., damage determination (Smith 1996). The economic value of an environmental asset can be broken down into two components of value: use values and nonuse values (Pearce 1993). Use values are further divided into direct or consumptive use, indirect or non-consumptive use, and option value. Nonuse values are the values society places on a resource simply for its existence such as the existence of endangered species.

The application of this valuation framework to a river resource ecosystem yields the following marketed (M) and nonmarketed (NM) direct use values which the study addressed: fisheries and other aquatic resources (M); household uses for washing and bathing (NM); commercial uses for laundry (M); recreational uses for swimming and fishing (NM); agricultural uses for irrigation and vegetable growing along river banks (M); biodiversity values for local medicine (NM); and transport uses for trade and mobility (NM). Indirect use values of the river as breeding and habitat grounds, waste assimilator, and other ecological functions are valuable services affected by pollution but were not addressed in this study due to data constraints. Nonuse or existence values were likewise not addressed for the same reason.

4.0 METHODOLOGY

4.1 Valuation Approach

In principle and following the conceptual framework presented above, damage determination should be implemented by estimating the change in the value of the resource as an asset. In the present case study, the net present value of the stream of services of the river as fishing ground, as source of water for irrigation and washing, as transport route and other services should be estimated through the expected life of the river, and the year-to-year changes in the value of these services as a result of mining pollution will be an approximation of the measure of the damage from pollution, other things being equal. In practice, however, a one-time estimate of the change in the value of the above-mentioned services of the river was generated. Then, the estimate

[4] In the U.S., the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 initiated the promulgation of regulations for Natural Resource Damage Assessments for oil spills and hazardous substance releases. While earlier legislation such as the Trans-Alaska Pipeline Authorization Act of 1973 and the Deepwater Port Act of 1974 explicitly allowed for recovery of damages from oil spills, it was the CERCLA that defined the process to be undertaken for damage recovery. Thereafter, the Department of Interior, which was given this responsibility, promulgated the NRDA regulations in August 1986 (see Kopp and Smith 1996, Smith 1994, and Dunford 1992 for an elaboration of the evolution of NRDA regulations in the U.S. and a discussion of the economic valuation issues related to the NRDA guidelines).

was projected over the expected duration of the damages using damage coefficients, and the present value of future damages was derived.

Estimating the economic values of environmental services requires the implementation of direct and indirect valuation methods. Various valuation methods are presented in the literature and the choice of method to use depends on the extent the observed data are derived from a real or hypothetical situation and whether the method generates monetary values directly or indirectly (Freeman 1993). Dixon et al. (1994) classified valuation techniques into generally applicable (i.e., changes in productivity, cost of illness, opportunity cost); selectively applicable (i.e., travel cost, contingent valuation); and potentially applicable (i.e., hedonic methods). This classification reflects the practical consideration of the measurability of the desired changes in environmental services.

Since in this study, one purpose of damage valuation is to serve as basis for damage compensation, the changes in the economic values of environmental services affected by the pollution were estimated in terms of productivity losses in the affected economic activities. This approach was deemed an appropriate basis for damage compensation to affected individuals because it provides an objective measure of the pollution damage in terms of foregone income. **Thus, the measure of environmental damage is the foregone income of households from the activity affected by the pollution as reflected in the productivity loss in that activity.** Section 4.2 discusses in detail the methods used in estimating the value of productivity losses from the different economic activities affected by the pollution.

The following sections explain the difficulty with or inapplicability of the frequently-used valuation methods in similar pollution-related events. These methods are contingent valuation, travel cost, and hedonic pricing.

Contingent valuation. Contingent valuation as an approach to benefit/damage estimation involves soliciting responses to hypothetical questions regarding the value people place on environmental amenities. The most commonly used hypothetical questions ask people for the value they place on a specified change in an environmental amenity or the maximum amount they would be willing to pay for the change to occur (Freeman 1993). A variation is the question on how much compensation people are willing to accept to endure or risk an environmental dis-amenity. These two measures, willingness to pay (WTP) and willingness to accept compensation (WAC), when aggregated over the population concerned, can provide a value of the resource as an asset. The literature on contingent valuation stresses the need to conduct properly planned surveys to eliminate the biases inherent in hypothetical or contingent-type of surveys (see Dixon et al. 1994, Freeman 1993, and Cummings et al. 1986 for a discussion of these biases).

Being an *ex post* evaluation, contingent valuation was deemed inappropriate as a valuation method of the mining accident because of the highly politicized situation that prevailed in the affected areas after the accident and is still prevailing at present almost two years after the accident. Moreover, the difficulty of implementing contingent valuation in a low-income, highly rural area to generate WTP/WAC measures as basis for damage compensation was recognized early in the study.

Travel cost. The travel cost method, which is extensively used to value recreational goods and services, requires data on people's observed visitation behavior to a recreational site. From these data, a demand curve for use of the site is derived. Then, the total amount of consumer surplus may be estimated. The estimated consumer surplus is a measure of the recreational value of the resource and is used as basis for estimating park entrance fees and related charges for use of a recreational site. However, the value of changes in the quality of a recreational site or changes in the quality of the flow of recreational services is better measured through a variant of the travel cost -- the random utility model, which does a "better job of capturing the role of site characteristics in influencing the decisions about whether to participate in recreation and the choice of a site to visit" (Freeman 1993).

In valuing the lost recreational uses of the river in this study, the opportunity cost of recreation time was used in lieu of travel cost which was deemed inapplicable to the case study. While the data collected indicated that the river was used for recreational activities such as swimming and picniking by most households, the accident left the river totally inappropriate for any kind of recreational use. The survey also showed that most of the substitute recreational activities consisted of watching TV, playing basketball, etc., which required no incremental expenditures. Since the loss in the recreational value of the river to the households can be considered as a total loss, the opportunity cost of recreation time was used to value the lost recreational services of the river. This opportunity cost, however, was valued at only 20 percent of the wage rate.[5]

Hedonic property value. One potential valuation approach to measure the value of lost services of the river is the application of hedonic pricing using changes in property values as a measure of pollution damage. The method is a surrogate-market approach which assumes that purchasers of property reveal their attitude to a bundle of attributes, including environmental, by their willingness to pay (Dixon et al. 1994). Through multiple regression analysis, the environmental attribute coefficient, after controlling for other attributes, is used to predict changes in property values given changes in environmental quality. The approach requires extensive data on the selling prices of individual properties as well as on their physical characteristics (e.g., location, size, distance to an environmental amenity).

The approach was not applicable to the case study mainly because the land market in the area was not active. Based on the responses of key informants in various villages in Boac, no extensive land transfers were observed within two years following the spill. However, a number of agricultural land owners in the Mansabang area sold their properties after the accident owing to low harvests and financial needs. In one affected barangay, a house-and-lot property was sold as an aftermath of the accident; part of the lot behind the concrete houses was eroded by the flash flood caused by the tailings spill.

Land transaction records at the Municipal and Provincial Assessor's Offices also showed a decreasing trend in new land transactions from 1995 to 1997 but an increasing taxable valuation or assessed value per parcel of land over the same period. Some of the recorded land transactions during this period that were related to the accident were the purchase by MMC of resettlement lands on which evacuation centers and core houses were built for the affected residents.

[5] Econometric studies in the field of transport demand reveal that the value of time for non-work related activities such as recreation tends to be only 1/5 of the wage rate (Algers, Tegner and Hansen 1974 and 1975).

4.2 Estimation Methods

4.2.1 Estimating productivity and income losses

The survey collected income data covering the year before the spill (1995) and the year of the spill (1996) which allowed the estimation of average income loss per affected livelihood per household due to the spill.[6] The following river-based livelihood activities were covered: river fishing, vegetable growing along river banks, rice farming, crops farming-trading, and laundry. In addition, income data on coastal fishing were collected since a large percentage of damage claimants were coastal fishermen affected by the spill. Foregone income was estimated in terms of changes in net income between the two time periods.

The general procedure for estimating income losses involved the computation of net revenue using productivity and cost data. The latter were usually provided by the respondents in monetary terms. Some respondents, however, reported net income right away, especially those in retailing. The net revenue was calculated by multiplying the production quantity (e.g., fish catch in kilograms) by the unit price (provided by the respondent), deducting any operating costs, and projecting the quantity or value of production per unit of time (per day, week or month) to per year basis, taking into account seasonal variations whenever relevant. The difference between the 1995 and 1995 net income was considered the income loss due to the spill for the particular affected livelihood.

The common assumption for the various livelihood categories was that the income change from 1995 to 1996 occurred during the nine-month period (April-December 1996) following the spill. The effects of independent variables specific to a livelihood activity that determine income levels were also assumed to be uniform across the samples.

To estimate the total foregone income in the affected areas using the survey data, the following assumptions were adopted: (a) the random samples are representative of the effects of the spill on household incomes in the entire affected population; (b) the same livelihood profile, the frequency distribution of the sample households according to types of affected livelihood, is obtaining in the respective sample stratum as a whole; and (c) the income changes from 1995 to 1996 occurred within nine months (April to December 1996) following the spill.

4.2.2 Estimating foregone nonmarket use values

Among the nonmarket uses of the Boac river, only the lost values of the river as source of recreation were estimated. Although traditionally the river has not been a source of drinking water, the survey data indicated that the local residents perceived their sources of drinking water (i.e., open and artesian wells) before the spill to have been contaminated by the river pollution and had shifted to alternative sources (i.e., piped water and developed springs). This occurred in spite of MMC's information drive that the drinking water from the wells was not contaminated by the tailings spill as

[6] Since the accident occurred at the end of the first quarter of 1996 (25 March), the income loss reported was actually experienced in the following nine months. That is, there was no income loss during the first quarter of 1996. However, the income data collected was for the 12 calendar months of 1995 and 1996; the difference was considered as income loss.

shown in technical reports (MMC 1996, 1997, and 1998; Placer Dome 1996 and 1997).

Recreation. The survey collected data on the average number of hours spent per week per household in river-based recreational activities, such as fishing, swimming, and strolling along river banks. As explained in Section 4.1, the lost recreational value of the river was estimated using the opportunity cost of recreation time which was valued at 20 percent of the wage rate.

Fetching drinking water. While drinking water is not strictly a nonmarket good, the household survey generated information on the incremental average number of hours spent per week per household travelling farther to fetch drinking water. This was done to capture the damage or cost arising from the households' perception that their previous source of drinking water had been contaminated. Assuming some positive opportunity cost of labor time, the additional time used for fetching water was valued using this opportunity cost.

Health impacts. An attempt was also undertaken to collect data on health impacts based on perception of local residents whether exposure to the mine tailings in the river and coastal waters posed risks to their health. While data were collected also on the mitigation or defensive measures the affected households undertook, these were not sufficient to implement valuation. This limitation notwithstanding, the survey results were processed and are discussed in Section 6.0.

Other household uses. Data collected on the other non-marketed uses of the river (e.g., being the source of water for household uses such as washing clothes, dishes and work implements, bathing draft animals, watering gardens, and bathing) were also not sufficient to implement valuation.

5.0 SURVEY OF IMPACT ON HOUSEHOLD LIVELIHOOD ACTIVITIES

5.1 The Survey Questionnaire

A survey of the impact of the mine tailings spill accident on the affected household livelihood activities was conducted to collect the following data: (1) income changes from primary and secondary livelihood activities in affected towns of Boac Municipality in two time periods (i.e., before and after the spill); (2) extent of use of the river for nonmarket purposes such as recreation and household uses; and (3) institution-related information, specifically on the government damage compensation policy.

The survey questionnaire was designed to collect primary data on the impact of the mining accident at the household level. Both affected and unaffected livelihood activities of the sample households were identified. Based on the income changes in these activities from 1995 to 1996, the foregone or lost household income due to the accident was calculated. Through random sampling, the proportion of affected households to unaffected households in the sample towns was estimated. The questionnaire also collected data on the number of affected households that have filed damage claims and have been compensated or uncompensated at the time of the survey (July 1997), as well as the number of households that have been affected but did not file their claims and their reasons for not doing so. The responses to the latter questions were relevant in formulating guidelines on damage assessment and compensation.

The survey questionnaire had four main sections: (a) socioeconomic characteristics of the household; (b) household livelihood activities; (c) nonmarketed uses of the river/coastal areas; and (d) institution-related questions.

5.2 The Sampling Design

The survey adopted a two-stage sampling design. The first stage, using data from the Marcopper Environment Guarantee Fund (EGF) Committee, classified the 44 affected barangays (villages) in the municipality of Boac into four strata (Table 1). Each stratum represented the major livelihood activity affected by the tailings spill for which residents had filed damage claims, namely: (a) coastal fishing (7 barangays); (b) river fishing (20 barangays); (c) farming (12 barangays); and (d) farming-trading (5 barangays). The barangays were stratified according to the livelihood activity with the highest number of compensated claimants. For example, Barangay Tabigue, with claimants consisting of 56 fishermen, 21 laundry women, and 11 farmers was listed under the coastal fishing stratum.

Within each stratum, the barangays were ranked according to their number of claimants, arranged from highest to lowest, and two barangays were chosen through systematic random sampling. This sampling procedure generated eight sample barangays, namely: coastal fishing - Laylay and Pili; river fishing - Daypay and Malbog; farming - Balogo and Boton; and crops farming-trading - Canat and Bayuti.

In the second sampling stage, a systematic random sample of 30 households was chosen from every barangay, which yielded a total of 240 sample households.[7] In each barangay, the third household from a landmark, usually the town hall, and every fifth household were taken as samples until the sample size of 30 was reached. Table 2 provides a summary of the final sample distribution by stratum and by barangay.

The survey was conducted by student enumerators of Marinduque State College under the direct supervision of the study's research associate. Most of the enumerators were graduating students taking up BS in Education. At least two were involved in an earlier survey also on the tailings accident conducted by the Bureau of Fisheries and Aquatic Resources of the Department of Agriculture.

6.0 ESTIMATES OF ENVIRONMENTAL DAMAGES FROM ACCIDENT-INDUCED MINING POLLUTION

6.1 Survey Results

Table 3 summarizes the socioeconomic characteristics of the sample households, and Table 4 shows the distribution of the sample households by livelihood activity. About two-thirds of the households interviewed were directly or indirectly affected by the accident-induced pollution, broken down by stratum as follows: coastal

[7] The total number of sample households analyzed was only 235 as one questionnaire in Barangay Boton was disregarded due to spurious income data and only 26 households were interviewed in Barangay Bayuti due to the relatively small number of the household population in that barangay.

fishing, 19 percent; river fishing, 18 percent; crop farming, 27 percent; and farm-trading, 36 percent.

6.1.1 Foregone market use values of river-based livelihood activities Table 5; Note: All values refer to income losses during the nine months following the accident.)

River fishing. River fishing was done mostly to meet daily food requirements, although when the catch was good, some were sold or given to relatives and neighbors. The survey yielded 39 (17%) sample households engaged in river fishing in four of the eight sample barangays. The average foregone income per household in 1996 was P5,599.

Rice farming. The impact of the tailings spill on rice farming was lower rice productivity because of reduced irrigation water supply coming from the river. Most of the affected farms were located in the 150-hectare irrigated ricelands in Sitio Mansabang, Barangay Buliasnin, where the water gate to the main irrigation canal was clogged by tailings deposit immediately after the accident. While irrigation was restored in about two months after the accident, the survey interviews indicated that only around 50 percent of the water requirement was being met by the remedial measure, hence, the lower rice production levels continued but with some improvement.

Affected rice farmers were categorized as land owners, tenants, and farm laborers, following the EGF classification. This was necessary to reflect the different levels of production income share from rice farming. During the months following the accident, among the three groups, the tenants incurred the highest household income loss of P11,017, followed by the farm laborers at P6,386; the landowners incurred an insignificant income loss of P1,487.

Crop farming-trading. The foregone income from this livelihood resulted from the loss of access to market by farmer-trader respondents, all of whom were from the two upland barangays under this stratum (i.e., Canat and Bayuti). The respondents represented 55 percent of the total household sample. In addition, 98 percent of the sample respondents were engaged in this livelihood as primary occupation and, except for two respondents, all reported income losses. Among the river-based livelihood activities, this activity had the highest average foregone income of P23,093 per household in 1996 following the accident.

Kangkong and vegetable farming. Kangkong (swamp cabbage) growers were treated separately from the vegetable/other crop farmers since their areas of cultivation were set up at the water edge, while vegetable gardens affected by the accident were cultivated in the low-lying areas near the river banks. Kangkong area were completely wiped out by the tailings spill, while the vegetable gardens were damaged in different degrees: some were flooded temporarily and others were smothered by silt. Kangkong was grown mostly for home use such as feeds for hogs; the rest was sold. The average annual income loss from vegetable farming was among the lowest among the livelihood types, averaging P2,932 per household, while average annual income loss from kangkong was P3,847 per household.

Laundry services. Respondents who were engaged in laundry services did not totally lose their livelihood since they shifted to other sources of water, although they indicated that the spill made their work more difficult and more time consuming, resulting in lower incomes. Regular laundry workers shifted to the use of artesian wells or piped water also for free. The average foregone income of laundrywomen respondents in 1996 was P4,954 per household.

6.1.2 Foregone market use values of non-river based livelihood activities

Coastal fishing. A total of 35 sample households (15%) from three barangays (Laylay, Pili and Balogo) were engaged in coastal fishing. The initial income losses experienced by coastal fishermen immediately after the accident were due to the pervasive fear of the local people of eating fish caught from the coastal waters near the river outlet. For a couple of months after the spill, fish was avoided as stories of alleged food poisoning spread and the seawater remained discolored by tailings silt. Whatever fish was caught at that time was bought at depressed prices. Unfortunately, data to validate this observation were not collected in the survey.

Later, however, coastal fishers reported a real reduction in their fish catch which resulted in foregone annual average income losses averaging P17,938 per household. The average monthly income loss for those who used non-motorized boats (n=31) was higher at P1,830 than for those with motorized boats (n=4) at P1,410. This result was expected since fishers with motorized boats can fish farther offshore to avoid the pollution and to the extent that their catch revenue could offset the added fuel cost. Thus, they were likely to suffer less than the non-motorized boat fishers who did not have similar options.

Fish retailing. The sampling came up with four respondents who bought and retailed fish in barangays Pili and Balogo. The two respondents from barangay Pili were engaged in fish retailing as their primary livelihood and were each earning P3,000 per month before the spill and experienced an average income reduction of P2,800 per month or an average of P28,263 per household in 1996. Fish retailing for the two respondents from barangay Balogo was a part-time occupation, from which they earned only P800/month. The average foregone income from fish retailing was P14,540 in 1996 following the accident.

6.1.3 Total foregone market use values of the river and coastal waters

Table 6 shows the estimated total foregone market use values of the river and coastal waters affected by the tailings spill in Marinduque in 1996. The survey-generated estimate of percentage of affected households (i.e., 65 % across strata, Table 4) was used to aggregate the total foregone income by barangay and strata (Table 6). The 65 percent overall proportion of affected households based on the survey was high compared with the 33 percent based on the May 1997 EGF Committee economic compensation summary (Table 1) but close to the 63 percent proportion of affected households based on the updated March 1998 EGF summary (see Section 8.0). (Note: The latter was not yet available at the time the sampling design of the study was implemented.)

About 80 percent of the income loss was accounted for by the impact of the pollution on river-based livelihood activities in the Boac river (strata I, II, and III) which affected more than half of the population of the Municipality of Boac. Among these activities, irrigated rice farming, which was dependent on river water, accounted for 50 percent of the losses.

6.1.4 Present value of future foregone income

In principle, a natural resource damage assessment (NRDA) involves an *ex post* analysis of values over time, which requires a "with and without" analysis of the observed state of the resource with the polllution (the "with" analysis) compared with a hypothetical or counterfactual alternative state in which there is no pollution (the "without" analysis), with all other factors assumed constant (Freeman 1993). In practice, the study used productivity, price, and cost data in 1996 to estimate foregone income for the "with" state, and compared this with the same data set in 1995 for the "without" state; it therefore assumed 1995 as a normal or representative year. In estimating the expected damages in present value terms, the projection assumed a stable income and population growth over a 10-year period during which the damages at varying degrees were assumed to persist.

Damage coefficients. The projection of future foregone income made some technical assumptions on the duration and degree of the damages over a 10-year project period, which were reflected in the damage coefficients used (Table 7).[8] A two-scenario projection was made: (1) with short-term rehabilitation, and (2) with long-term rehabilitation. The "with short-term rehabilitation" scenario considered only the immediate remedial measures already undertaken by the mining firm to mitigate the impacts of the tailings release, such as plugging of the tunnel, levee and silt curtain construction, and the construction of a dredge channel. The "with long-term rehabilitation" scenario considered both the completed short-term as well as the proposed long-term rehabilitation activities of the firm, specifically, the adoption of a permanent solution to the disposal of the remaining tailings in the Boac River, which was projected to be completed by the year 2001. Additional assumptions for each scenario are given as footnotes in the tables. The assumptions relating to natural processes (e.g., rainfall) hold for both scenarios.

In principle, damage coefficients should be quantitatively measured, using technical data as basis of the coefficient estimates. For river fishing, the following data would be useful to use as basis of the coefficients: percent reduction in the rate of natural sediment transport along the river, the daily percent extraction of tailings from the river by physical measures, or the percent reduction in the suspended sediment concentration in mg/liter/day. For coastal fishing, data on percent performance efficiency of the dredged channel as temporary repository of the tailings and the percent reduction in the sediment off-shore flume are useful in coefficient estimation. In the absence of such data, an alternative, albeit less scientific, means of developing the damage coefficients was used, which was the Delphi Method where a group of experienced personnel and experts was convened to get some consensus on some pre-determined coefficients.

The present study partly applied the Delphi Method and developed a set of arbitrarily, pre-determined coefficients based on the field exposure of the researchers,

[8] A 10-year scenario was selected in consideration of the strong commitment of the mining firm involved to totally rehabilitate Boac River mid-way during this time period; therefore, the damages beyond this period were expected to be negligible in present value terms.

including site visits, survey of affected households, interviews of key informants, and the technical documents available to them. Starting with a damage coefficient of "1" to represent the current year's damages, the coefficients were adjusted downward or remained the same after consideration of the information from the above sources. Due to time and budget constraints, only three natural science and engineering experts, all of whom were very knowledgeable about the mining accident, were consulted on the coefficients and their inputs were incorporated in a refined set of coefficients (Table7).[9]

PV of foregone income. Table 7 also shows the present values (PV) of expected foregone income for the two scenarios over the 10-year period following the accident, using the assumed damage coefficients and a 15 percent discount rate. The present value estimates under Scenarios A (with short-term rehabilitation) and B (with long-term rehabilitation) were P180 million and P162 million, respectively. The less than P20 million difference between the two scenarios could be explained by the delayed implementation of the long-term rehabilitation plan, the impacts of which would be felt only in the second half of the ten-year scenario period.

As a measure of damage, the PV estimates of expected foregone income are **minimum** estimates of the lost **direct use** values of both the river and coastal ecosystems resulting from the mining pollution. **These estimates exclude the lost nonmarketed use values of the river such as recreation (which was not projected) as well as the indirect use values such as ecological uses and the nonuse values of the river, which may be substantially higher than the foregone income losses.**

In addition to being estimates of the total compensation due the affected households, they may also be considered as **minimum** values of the total compensation due the public trustee of the injured natural resources. This compensation could be in the form of a lump sum payment in lieu of individual compensation payments. In the case of the Marinduque mining accident, the local government acting on behalf of the community may be considered the public trustee of the Boac River and the affected coastal waters.

6.1.5 Foregone nonmarket use values of the Boac river

Recreation. All of the household respondents from the two river barangays, Malbog and Daypay, engaged in river recreation before the mining accident. In barangay Boton, which belonged to the crop farming stratum but was also located very close to the Boac River (see map), all of the respondent households also engaged in river recreation before the accident. Table 8 shows the estimated lost recreational value of the river for swimming and fishing to the households in these three barangays.

About 83 percent of the respondents swam in the river as a recreational activity. After the accident, which left the river very polluted, no swimming activities had been done. The total lost economic value of the river for recreational swimming in 1996 was estimated at P111,458 for the three barangays.

Only 16 percent of the respondents reported river fishing as a recreational activity. The estimated value of the lost recreational use of the river for fishing was

[9] Dr. Ricarte Javelosa, geologist/geo-engineering specialist/environmental geomorphologist; Engr. Rodolfo Velasco, mining engineer; and Prof. Roger Birosel, molecular biologist/practicing ecologist

P8,319 in 1996. The total lost use value of the river for recreational swimming and fishing in 1996 was P119,777.

Fetching drinking water. As indicated earlier, while the Boac River was not traditionally used as a source of drinking water, the survey indicated that 14 percent of the sampled households perceived that their source of drinking water had been contaminated by the pollution from the mining accident. Of this, 62 percent were households from barangay Boton, all of which indicated they had to travel farther to alternative sources of drinking water. Among the river barangays, Boton is closest to the river and this may explain why the perception of contaminated water was strongest in this village.

The opportunity cost of fetching drinking water from alternative sources in the three affected barangays is shown in Table 9. The total lost economic value arising from people's perception of contaminated drinking water was P49,723 in 1996.

Health impacts. The survey collected data on the sample households' perception of the health impacts of exposure to the river and coastal waters polluted by the mine tailings. About 30 percent of the respondents perceived that exposure to the polluted waters entailed some health risks. Table 10 shows the illnesses perceived to be caused by such exposure. The two most common illness the respondents associated with exposure to the polluted waters were skin disease (57 households reporting) and stomach disturbances (34 households reporting). Other notable ailments reported were upper respiratory illnesses, dizziness and headaches. There were fewer households in the coastal barangays compared with river barangays which associated certain illnesses with the polluted waters.

The most common preventive measures the households undertook to avoid exposure to the polluted waters were: (1) stopped bathing in the river (37); (2) stopped eating fish from the river/coastal waters (34); and (3) stopped swimming in the river/coastal waters (33); and (4) washed clothes elsewhere (22) (Table 11). No respondent reported purchasing bottled water as a mitigation measure, although 13 households reported they boiled their drinking water as a preventive measure.

The survey did not collect data on the frequency and incremental cost, if any, of the preventives measures undertaken. Valuation of the health impacts of the pollution was therefore not possible to implement. Even so, the results indicated some positive economic cost was incurred by the affected households through the adoption of defensive or preventive measures as discussed above.

6.1.6 Institution-related Issues

The survey collected information from the respondent households on the EGF and the results were as follows (Table 12):

Existence of the EGF. The EGF, as a government program, was largely unknown to most of the respondents. Most (86 %) of the respondents interviewed were not aware of the existence of the EGF, even among damage claimants. Because EGF is an English term, only the educated and barangay officials were aware of its existence and purpose. These respondents had knowledge of the EGF as a fund allotted specifically to compensate for livelihood income losses arising from the mine tailings spill. A few expressed awareness of the existence of some compensation money.

Adequacy of compensation received. Most (91%) of the affected household respondents who were compensated under the EGF reported dissatisfaction on the amount received as damage compensation. Part of the problem with this issue was the fact that affected households filed damage claims for nine months initially (April - December) as directed by the EGF Committee, but the compensation provided covered only five months (April through August).[10] This was necessary since the EGF Committee decided to provide the first set of compensation payments in August and did not wish to pay for any damages that were not yet covered by the compensation period. When asked about the adequacy of the compensation received, many of the households had as their reference the amount they filed covering the nine-month period. One-fourth of the compensated claimants indicated that only one-fourth of the damage claim they filed was paid by the EGF. Only 5 percent expressed satisfaction on the compensation amount they received.

Length of processing time. When asked about the processing time for damage compensation, most of the respondents (81%) felt that it was too long. The processing time was defined as the time the claimant filed his/her claim up to the time the payment (check) was received. While many felt that the processing time was long, most indicated that they were not upset about it because their attitude was to simply forget about the claim after filing it.

Transactions cost. Two-thirds of the respondents reported minimal or no expenses incurred in the filing and following up of their damage claims. Expenses incurred consisted of minimal amounts for reproduction of documents, transportation, and getting a residence certificate. Only one respondent indicated that he provided the concerned local government personnel with a token cash gift as a facilitation fee.

Resumption of Marcopper mining project. Eighty-four percent of the respondents indicated they did not want the Marcopper mining project to resume operations. Most of these respondents felt that so many people had suffered already; they feared for their families and barangays should a similar accident happen again. Some respondents (6%) recognized the contribution of the project to employment, and 10 percent of the respondents would rather let the government make the decision on the matter for the community, or allow resumption only if there is assurance that the accident will never occur again.

7.0 RESTORATION COST AS AN ALTERNATIVE MEASURE OF ENVIRONMENTAL DAMAGE

In addition to the discounted foregone use values of the river, an alternative measure of natural resource damages in the Marinduque mining accident is the cost of restoring or rehabilitating the river to its pre-release condition. In the U.S., the estimate of the cost of restoring an injured natural resource to its pre-damage state is favored as basis for compensatory damages by the U.S. Court of Appeals over an estimate of the reduction in value of the flow services of the injured resource. The argument is that

[10] Compensation payments for the period September-December 1996 were eventually provided (see Section 8.0).

monetary values as a measure of the value of a public asset is an understatement of its social value (Smith 1996). However, for purposes of determining compensatory damages to affected individuals for direct use losses of the services of the resource, this study argues that the foregone use values are a more appropriate measure.

7.1 Short-term Mitigation Activities in the Boac River and Affected Communities

Immediately after the accident, Marcopper and government agencies conducted relief operations and dispatched medical missions to affected communities. The Marcopper Environmental Guarantee Fund (EGF) compensation mechanism was activated with the formation of a Committee and Secretariat to oversee the fund's dispensation, most of which was allotted for damage compensation payments and construction of core and evacuation centers (see Section 8.6). In addition, Marcopper spent funds outside the EGF for infrastructure-related activities such as road repair and construction of new access roads to remote barangays isolated by floods. Relief and medical missions were dispatched to the affected areas immediately following the accident.

A number of activities had been undertaken to address the deposition of the tailings in the river system. First, the drain tunnel was plugged twice to stop tailings flow from the Tapian Pit: a temporay plug was installed in October 1996 and a permanent plug in August 1997. Second, temporary levee banks of up to 2.5 m in height were constructed along the 27-km stretch of the Boac River to minimize spread of tailings and mitigate the increased risk of flooding caused by the tailings deposited up to 1.4 m in depth. Third, a silt curtain was provided approximately 20 m from the mouth of the river (inward) to break the flow of water. Lastly, tailings at the Boac River mouth were dredged at a certain depth to allow silt from upstream to settle. Work on the channel commenced in mid-August 1996 and was completed in September 1996. Dredged materials were placed at the banks of the 1-km long, 100-m wide, and 6-m deep dredged channel. Some 193,000 cu m of tailings material and natural sediments had been deposited in the channel by the end of February 1997 and the entrapped materials were estimated to reach 400,000 cu m, filling the channel by August 1997 (Report on Boac River Channel Dredging June 1997). The cost of the dredged channel reached P208 million.

7.2 Long-term River Rehabilitation/Restoration Options

Table 13 summarizes the seven options addressing the tailings deposition in the rehabilitation of the Boac River, namely: (1) landfill, (2) haul to Tapian Pit, (3) pump, (4) coastal reclaim, (5) settling basis, (6) deep ocean disposal either by river or settling basin, (7) dredged channel, with corresponding estimated costs. Each option was evaluated by those concerned on technical, social, and economic grounds. The construction of the dredged channel had actually been completed at the time of the study; however, the option to redredge the channel was being evaluated. Assuming the redredging would cost the same as the original dredging and that it will address the tailings deposition adequately, this activity appears to be the least costly among the options. The cost, however, excluded the externalities from the redredging activities such as lower fish productivity and others.

Given the serious social and environmental implications of some of the options, a cost-effectiveness analysis of the various rehabilitation options may not be sufficient to guide the decision-maker on the most efficient method to rehabilitate the river. In particular, the option of coastal reclamation has serious implications to the fishery resource, since a large area of the beach would be impacted and considering the potential acid mine drainage. A cost-benefit analysis could provide a better basis for identifying the most efficient method to rehabilitate the river among the given options.

In more recent MMC and Placer Dome public documents (1997, 1998), the long-term rehabilitation options being considered for restoring the pre-spill conditions of the Boac River had been narrowed down to five, namely: (1) encapsulated landfill, (2) submerged landfill, (3) dredge another channel, (4) managed submarine placement, and (5) do nothing. All first four options were preferred to the "do nothing" option, which was not viewed as an acceptable solution by the regulatory authorities and the public, even though minimal environmental impacts were predicted to be negligible by the experts. Among the four options, the managed submarine disposal was assessed by consultants as the best long-term solution to address the fate of the remaining tailings both in the river and in the dredged channel.[11]

8.0 GOVERNMENT LIABILITY AND DAMAGE COMPENSATION POLICY ENVIRONMENT AND THE MARCOPPER EGF

This section (1) reviews the existing Philippine policy environment with respect to liability and damage compensation; (2) discusses the Marcopper EGF compensation process and some issues arising from its implementation; (3) draws some policy and implementation lessons from the Marinduque mining accident; and (4) examines some analytical issues related to the efficiency of alternative liability rules.

8.1 Current State of Philippine Liability and Compensation Policies

The Philippine government policy on the prevention of potential injury to environment-resource systems is enunciated in the Philippine Environmental Policy and the Philippine Environmental Impact Statement (EIS) System under Presidential Decrees 1151 and 1586, respectively (EMB 1994). The EIS System, introduced in 1977 and is now fully institutionalized, requires all proponents of projects with potential environmental impacts to prepare an environmental impact assessment (EIA). The EIA is a systematic study of the cause-and-effect relationship between the proposed project and its surrounding environment and recommends actions to mitigate environmental impacts. The preparation of an EIA is a condition to the issuance of an Environmental Compliance Certificate (ECC), which certifies that the proposed project will not bring about an unacceptable environmental impact and that the proponent has complied with the requirements of the EIS System.

Under the EIS System, the Environmental Guarantee Fund (EGF) requires all projects with potential harmful effects to the environment to set aside a fund intended for various purposes including environmental monitoring, damage compensation and rehabilitation. It is a financial arrangement negotiated between the project proposal, the Department of Environment and Natural Resources (DENR), the concerned local government unit, and the affected community. The EGF policy indirectly establishes a

[11] A recently conducted social impact assessment of these long-term rehabilitation options concluded that the "augmented riverine disposal with submarine placement" option would have the least social impact while land disposal would have the most serious social impacts (MMC 1997, 1998; Placer Dome 1997, 1998).

liability to potential polluters for environmental damages that may arise from project activities.

In addition to the EGF as a "liability" instrument, the mining sector, until 1995, was regulated by Presidential Decree No. 1251 or the Mines Wastes and Tailings Fee (MWTF), which imposes a fixed charge per unit of ton of wastes or tailings discharged to the environment. The fees were collected and set aside by government and used exclusively for compensation of damages caused by mine wastes and mill tailings on private lands, agricultural crops and forest products, marine life and aquatic resources, infrastructures, and the revegetation and rehabilitation of silted farm lands and other areas devoted to agriculture and fishing as well as to damages on human health. A Committee created under PD 1251 oversaw both the fee collection and fund disbursement to damage claimants. For the period 1981-93, a total of P20.8 million had been collected as MWTF, out of which P12.6 million have been disbursed from the fund as damage compensation.

With the passage of the New Mining Code of 1995 (Republic Act 7942), the liability of the mining sector for environmental damages is now contained in the provision on the institutionalization of an environmental guarantee fund mechanism called the Contingent Liability and Rehabilitation Fund (CLRF).[12] The CLRF sets aside funds for the compensation of damages and mine rehabilitation. It has two fund components: (1) the Mine Rehabilitation Fund, a trust fund to be established by the contractor/permit holder to be used for physical and social rehabilitation of areas and communities affected by mining activities and for research on the social, technical, and preventive aspects of rehabilitation; and (2) the Mine Wastes and Tailings Fee Reserve Fund, to be made up of the MWT fees collected from mining companies as provided in P.D. 1251, to be used exclusively for damage compensation.

In terms of damage compensation guidelines, the rules and regulations implementing R.A. 7942 are explicit as to who are qualified to claim compensation and how the compensation is determined. Compensation guidelines specific to the Marinduque mining accident were formulated soon after the accident (see Section 8.0). The guidelines provide for full compensation of damages to the affected households in terms of the foregone incomes from economic activities affected by the pollution.

8.2 The NRDA Process of the Marinduque Island Mining Accident

Since the DENR has not formulated any guidelines on damage assessment of natural resources injured by the release of hazardous substances into the environment, there was no systematic assessment of the damages resulting from the mining accident. Various groups conducted independent assessments, among which were the United Nationals Development Programme (UNDP) which deployed an Expert Assessment Mission to Marinduque island upon the request of the Philippine

[12] In a recent Memorandum of Agreement (MOA) between the Mines and Geosciences Bureau (MGB) and the Environmental Management Bureau (EMB), these bureaus of DENR agreed that project proponents in the mining sector will no longer be required to set up environmental guarantee funds since the MWT fees are already intended exclusively for damage compensation. Project proponents, however, are still liable for **all** the damages arising from any pollution activity, whether recurring or accidental, and are required to replenish their respective MWT fund in the event the compensation required is larger than the existing fund. In addition, they are required to purchase environmental insurance once the market for such insurance is available in the country (R. Velasco, Jr., personal communcation).

government, during the period 26 April to 3 May 1996; Placer Dome, the mother company of MMC until its divestiture from MMC recently; the Philippine Rural Reconstruction Movement, a local non-government organization (NGO); and the University of British Columbia jointly with the University of the Philippines' School of Urban and Regional Planning (UNDP 1996; Placer Dome 1996, 1997; MMC 1996, 1997; Vidler 1996; UBC/UP-SURP 1996). The DENR, through its Mines & Geosciences Bureau (MGB), also implemented its own technical evaluation of the impacts of the accident (MGB 1996).

Except for the UBC/UP-SURP report, all of the evaluations conducted focused on the injury determination stage of the NRDA process, where the physical impacts to the injured resources (both natural and human) were examined and attributed to the release of the mine tailings. The UBC-UP-SURP study was a rapid social impact assessment of the spill and estimated damages in monetary terms. The results of a Department of Agriculture study were not made available to the researchers.

8.3 The Marcopper EGF

8.3.1 The damage compensation process

At the time of the mining accident, the government also had no guidelines on damage compensation under the EGF program. This section describes the damage compensation process in the case of the Marcopper EGF which resulted in the formulation of draft guidelines as shown in Attachment 1. Lessons could be drawn from the Marcopper EGF compensation process for similar future developments as it is considered as the first test case of the government's damage compensation policy as embodied in the EGF.

The Marcopper EGF was established immediately after the implementation of the EGF in 1991. It had not been used until the spill. At the time the Marcopper tailings spill occurred in March 1996, the Marcopper EGF, which started at P5 million, was immediately activated to meet damage compensation and monitoring expenses as a result of the accident. The P5 million fund has since then been replenished several times.

At the time of the tailings spill, DENR, which oversees the EGF, had not issued any guidelines on damage assessment and compensation. The guidelines used in processing the damage claims were formulated by the Marcopper EGF Committee following the accident. The Committee took about five months to formulate the guidelines (Attachment 1). The guidelines specified the people with rights to claim for damages, the steps in processing damage claims, and the documents required in damage claims. In addition, some bases for determining the compensation were provided, although no guidelines on the computation of the compensation were given.

The Municipal Social Welfare and Development (MSWD) Office was assigned the responsibility of validating and assessing the damage claims. The barangays officials were mobilized to expedite the filing and validation of damage claims from affected households within their constituency. They organized barangay meetings and conducted household visits and follow-up activities to ensure the successful implementation of the process in accordance with the guidelines.

The guidelines required damage claimants to accomplish and file two forms and a number of supporting documents. The first was the Application for Rehabilitation Aid and Damage Claims which provided basic data about the household. The second was the complete listing of damages per household (*Kabuuang Tala ng Pinsala Bawa't Pamilya*). Among the supporting documents required were the following: (1) certification of the Barangay Captain that the claimant is a bonafide resident of the barangay, a victim of the disaster, briefly stating the damage in terms of livelihood and property loss; and in the case of rice farmers, certification as to land ownership, tenancy, or farm labor employment; (2) Declaration of Real Property (riceland, plants and trees); (3) latest income tax returns; (4) for laundry losses, certification of *labandera* employer as to services of claimant and payment rate given; (5) for coastal fishing losses, registration of motorized boat and other official receipts; (6) mortgage papers, if necessary; and (7) residence certificate.

Within weeks after the accident, the local residents filed their applications for rehabilitation aid and damage claims. The application form listed only losses incurred from the tailings spill on property such as residential land and house, agricultural land and plantation, other properties such as fishing boats, and livestock. In addition, the form indicated any occurrence of death or illness due to the spill. While the guidelines were being formulated, applications for claims were being accepted and processed such that as soon as the guidelines were issued, the first batch of claimants was compensated thereafter (in August 1996).

Damage claims were assessed through interviews with claimants, validation through inter-barangay comparisons of similar claims, and consultations. Specialists from various government agencies such as the Department of Agriculture, National Irrigation Authority, and Bureau of Fisheries and Aquatic Resources were tapped to assist the assessment team in reviewing the applications. Complaints were accommodated and resolved through consultations.

8.3.2 Some issues on the compensation process

The issues discussed below were distilled from both the survey results and interviews with key informants as well as from the "Guidelines on the Processing of Damage Claims in Relation to the Calamity Wrought by the Discharge of Mine Tailings of Marcopper Mining Corporation into the Boac River" formulated in August 1996, which was the basis for the compensation payments to the affected parties.

1. Coverage of qualified claimants. While the guidelines were explicit on who has the right to claim for damages, the compensation process limited damage claims to one claimant per household in some cases but allowed multiple claims in other cases. Some household respondents who were affected but did not file indicated that they were informed that only one claim per household was allowed. Interviews with the EGF Assessment Team indicated that these were few isolated cases and some applications were rejected not for that reason but due to absence of supporting documents.

2. Coverage of qualified livelihood activities. Again, while the guidelines were clear on the livelihood activities qualified for compensation, they were silent on whether compensation should cover only damages in primary occupations affected or should include secondary or subsistence livelihood activities. Many of the affected households were small crop growers and small river fishers whose produce and catch

were chiefly for home consumption. Some of them did not file applications as they were informed that their activities did not involve cash income or were part-time in nature. In fact, the guidelines set minimum income levels by livelihood activity, below which the activity would not qualify for compensation (see issue no. 4).

3. *Coverage of compensable period*. The guidelines stated that the damage compensation period shall cover the time the accident occurred (i.e., 24 March 1996) until the river is rehabilitated or remedial measures are undertaken to normalize the livelihood of the people. However, uncertainty over the compensable period was expressed by many affected household respondents. The EGF compensable period was initially for 5 months (i.e., April-August 1996) and then for another 4 months (i.e., September-December 1996). At the time of the study, it was not clear whether the compensable period will be extended beyond December 1996 to cover damages in terms of foregone income still being incurred due to the pollution.

4. *Bases for determination of amount of claims*. The guidelines stipulated the minimum daily or monthly income per household from the affected livelihood activity to qualify for compensation. For example, for households engaged in river laundrying, a minimum daily income per family of P100 (or P350 weekly income) must be derived from the activity. For small farmers growing cash crops along the riverbank, the minimum monthly income should be P1,000 per household. In some cases such as coastal fishing and farm-trading livelihood activities, disagreements between claimants and the assessment team led to negotiated rates for compensation (i.e., P2,000 per month as across-the-board income loss from coastal fishing

5. *Length of processing time*. The guidelines stated that compensation will be paid within 15 days after the approval of the EGF, but there was no stipulation on the processing time between filing of the claim and approval by the EGF Committee. In the Marcopper EGF compensation process, the first payments were made in August 1996 to two barangays only (i.e., Bamban and Balagasan) and subsequent payments were given a year after. At the time of the study, the compensation process was still ongoing for the nine-month compensable period (i.e., April-December 1996) agreed by the EGF Committee. As shown earlier, the survey results indicated that more than 90 percent of those who received compensation felt that the processing time was too long.

8.3.3 Summary of the economic compensation

As of February 1998 (almost two years after the mining accident), the total economic compensation paid out from the Marcopper EGF has amounted to P21.6 million covering 3,535 affected households in 47 barangays, all in the Municipality of Boac (Table 14).

Damage claimants have been classified into batches. Damage compensation for the five-month period from April to August 1996 had been completed for the first batch of claimants. The total payments had reached P16.8 million by 27 August 1997. The compensation for the remaining four months (September-December 1996) had totaled P6.1 million as of 24 March 1998. Meanwhile, claims from the other barangays were being processed. Including expenditures for core houses and evacuation centers, a grand total amount for damage compensation of P30 million had been released to date.

The second batch of claim applications was being processed and the estimated total amount for 46 barangays was P12.5 million, covering the nine-month period from April to December 1996.

A separate compensation for damage to property was also under process, covering five barangays. These were claims for coconut trees, nipa, bamboo and crops destroyed, inundated, or smothered by the tailings spill. According to the Marcopper EGF Coordinator (p.c. March 1998), the compensation rates used by the Assessment Team were higher than the 1993 market values of the Municipal Assessor's Office. Moreover, additional compensation for income losses in 1997 incurred by the Mansabang rice farmers, was being considered.

8.4 Some Liability-cum-Compensation Policy and Implementation Lessons from the Marinduque Island Mining Accident

The Marinduque mining accident is an interesting test case of the government's policy on liability and compensation as embodied in its EGF policy and, therefore, the implications on future developments in this policy area are worth examining, albeit in broad terms in this report. The accident was the first of its kind in the country that occurred within the EGF policy environment, both in terms of magnitude of tailings release and extent of damage caused on economic activities of the affected population.

It may be reasonble to assume that the EGF policy was formulated to enhance the acceptability of a resource extraction project, such as mining, by the concerned community, which addresses the externalities problem indirectly. As such, the policy instrument was formulated without adhering to economic theory and principles, particularly in terms of optimal rate setting to induce efficient mitigation behavior on the part of polluters and externality victims.

The above notwithstanding, the efficacy of the EGF policy was tested in terms of the liability obligations of the polluter in the Marinduque mining accident. The Marcopper EGF which was initially set at P5 million was replenished several times to meet the financial requirements arising from the accident such as relief operations, damage compensation and rehabilitation, with a large portion of the total expenditures on rehabilitation financed outside the fund. Compensation payments, however, covered only the nine-month period following the accident, despite the reality that pre-spill conditions of the injured resources had not been achieved and, therefore, some economic activities of affected households had not returned to normal two years after the accident, and damages continued to be incurred.

As a result of the lack of clarity in the EGF policy guidelines with respect to the exact nature and extent of the liability of polluters in events such as the Marinduque mining accident, it is uncertain whether additional compensation payments will be made to the affected households. This uncertainty in compensation payments, coupled with paper processing delays, has contributed to the widespread discontentment among damage claimants surveyed on the compensation process (see Section 6.0).

In the meantime, the operations of the mining project have been suspended since the accident, pending the DENR's approval of a rehabilitation plan of the mining firm. Again, it may be reasonable to assume that the strong sentiment of the local population against the resumption of the project operations has been mainly behind the continued suspension of the project's operations, following the earlier assumption that the rationale in the formulation of the EGF policy was to enhance community acceptability of environmentally critical projects. It is further reasonable to expect **a priori** that the nonresumption of Marcopper's mining operations would have economic efficiency and welfare impacts and that these would be worth investigating in support of future policy development in this area.

The Marcopper EGF compensation process showed some deviations between the guidelines formulated by the EGF Committee and the actual implementation of those guidelines, which may have partly contributed to the large discrepancy between the actual EGF compensation payments made and the compensation estimates generated by this study. Consistent implementation of policy guidelines is necessary to preserve the integrity of the compensation process.

8.5 Some Issues on the Economic Efficiency Effects of Liability-cum-Compensation Policies

This section discusses some analytical issues related to the efficiency effects of liability-cum-compensation policies, more specifically, whether victims of externalities should be compensated or not and whether liability rules induce efficient behavior by polluters and victims. While these issues are not rigorously addressed in this report and are treated in general terms, this brief exposition is expected to lead to a better appreciation of the policies discussed above and serve as inputs to future policy development in this area.

Baumol and Oates (1988; henceforth referred to as B&O) argued that compensation of externality victims is not economically efficient because it acts as a disincentive to the victims to engage in appropriate levels of defensive activities. They argued further that compensation of externality victims induces excessive production of the victim's activity. B&O referred to compensation as a compensatory payment to victims of externality which is directly proportional to the level of damages experienced by the victim. The one-to-one correspondence between the amount paid by the polluter and that received by the externality victim prevails in a strict liability rule where the polluter is liable for all damages irrespective of adoption of mitigation measures. This payment is distinguished from a lump-sum compensation payment which is not dependent on the damage levels and therefore is the same for all the externality victims involved. B&O argued that any compensation payment to victims of externality must be lump sum to ensure efficient victim incentives and prevent distortionary impacts.

In their general equilibrium externalities model, the authors showed that a compensatory payment to externality victims violates the Pareto optimality requirements of resource allocation in the following ways:

(1) Any mitigation behavior on the part of the victim is an expenditure item and affects the utility function of the externality victim. A rational externality victim will minimize the expenditure necessary to achieve any given level of utility. Under a compensatory payment or strict liability regime where liability payment of the polluter is equal to damages generated and is used for victim compensation, the latter will equate his or her level of mitigation or care to zero, in the face of potential pollution damage, with the expectation of full compensation of any damages he will experience.

This moral hazard problem is distortionary and leads to inefficiency in resource allocation.

(2) Since a compensatory payment is directly proportional to the externality victim's activity level, any autonomous or exogenous increase in the victim's activity level would proportionately increase damages to the victim and in turn increase compensatory payment to the victim. The increase in compensatory payment will induce the victim to increase its output level independent of market behavior, thus creating more damages.[13]

Segerson (1995) examined the efficiency results of alternative liability instruments and compared these with those under a Pigovian tax regime. She distinguished three types of liability instruments into: (1) strict liability, where the polluter is liable for all damages irrespective of level of mitigation measures; (2) strict liability with contributory negligence, where the externality victim is held responsible (and therefore not compensated) for part or all the damages if found negligent in undertaking mitigation measures; and (3) negligence, where the polluter is liable only if found negligent in undertaking mitigation measures. For each of these instruments, a further distinction is made between cases of unilateral care, where only the decisions of the polluter determine damages, and bilateral care, where the mitigation behavior of the externality victim can also affect damages in addition to the polluter's behavior.

Segerson (1995) concluded that liability instruments have different efficiency results depending on the amount of care or mitigation of the polluter and the victim and their activity levels. In general, in bilateral care cases where there is a one-to-one correspondence between the polluter and the victim on the compensation paid and received, none of the liability rules promote efficient incentives for all decisions on care and activity levels; otherwise, these instruments can approximate the efficiency properties of the Pigovian tax instrument depending on whether victim incentives and output levels are important determinants of damages. A case in point where a strict liability rule will promote efficiency in care or activity levels is made by the author of stochastic pollution events, such as oil spills, where strict liability for damages is imposed on the polluter under U.S. statutes but the mitigation behavior of externality victims is not relevant.

The discussion above on alternative liability rules and their efficiency effects highlights the observation that the existing policy environment on the liability of polluters for injury caused to natural resource systems from mining activities is ambiguous. Polluters' liability appears to be only implied through the provisions on damage compensation to externality victims. In the absence of any appreciation in existing policies on the mitigation behavior of the externality victims, and given the provisions on damage compensation to externality victims, it is reasonable to infer that polluters in the mining sector are liable for environmental damages under a strict liability rule. A specific instance where current liability policy is vague is in the imposition of a fee on every ton of mine wastes and tailings (MWT) discharged into the environment. While this policy appears at the outset to be a Pigovian tax of some sort, on closer examination it is not since (1) the fee was imposed without any reference to marginal social damage; and (2) the revenues are set aside exclusively for damage compensation to externality victims.

[13] Readers interested in the mathematical formulations of the B&O arguments are referred to Baumol and Oates (1988), chapter 4, and Segerson (1995), chapter 13.

The efficiency effects of such a policy environment under different pollution events (i.e., stochastic vs. recurrent) are interesting both as an analytical and empirical question. The task of exploring other policy regimes to address the externalities problem becomes particularly necessary when the inherent difficulties in setting the required levels of Pigovian taxes are considered, possibly making liability-cum-compensation policies as second-best options to a Pigovian tax regime.[14] The workings of the legal system, however, are an important factor in determining the effectiveness of a liability rule regime.

9.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study estimated the foregone income of the residents of the Municipality of Boac whose economic livelihood activities were affected by the Marinduque Island mining accident. This estimate was used as a measure of the environmental damage from the accident-induced mining pollution inflicted on the livelihood of the local residents affected by the pollution. It also provided a minimum value of the lost market use values of the affected natural resources (i.e., river and coastal waters). The study demonstrated the application of some economic valuation methods to estimate environmental damages from pollution. The principal method used was the change-in-productivity approach to estimate foregone income from economic activities affected by mining pollution.

The present value of the estimated total damages over a 10-year period in terms of direct use values of the river and coastal waters affected by the tailings spill amounted to P180 million under the "with short-term rehabilitation" scenario and P162 million under the "with long-term rehabilitation" scenario. The estimated foregone income in 1996 of P50.1 million was slightly more than 50 percent of the total provincial income of P95.0 million and was more than twice the total municipal income of Boac of P21 million in 1996.

The study also generated economic values of the nonmarket use of the river for recreation (i.e., lost recreational values). The health impacts of the pollution as perceived by the affected local residents were also examined but were not translated into monetary values. While the estimated lost economic values from river-based recreation, primarily swimming, were not significant compared with the foregone direct use values of the river, the study revealed that rural households experienced such nonmarket losses brought about by pollution. The study suggests increased use of economic valuation methods rather than the opportunity cost method to estimate lost recreational values in similar pollution-induced incidents as part of natural resource damage assessment.

The positive opportunity cost of fetching drinking water from alternative sources brought about by the affected households' perception that their pre-spill sources of drinking water were contaminated by the pollution, though the technical studies indicated otherwise, highlighted the need for a more effective public information to avoid incurring economic losses. This is also true with the losses incurred by the

[14] Baumol and Oates (1992) argued that, given the Herculean task of designing a Pigovian cure to the externalities problem, other options should be explored such as the "environmental pricing and standards" approach which they proposed.

affected households who adopted mitigation measures to avoid exposure to the polluted waters.

The study examined the current policy environment in the mining sector with respect to liability-cum-compensation and the compensation process related to the implementation of the Marcopper Environmental Guarantee Fund during the two-year period following the mining accident. The survey-based estimates of economic compensation resulted in higher compensation schedules for the four major affected livelihood activities covered by the study compared with actual compensation payments. The estimated total income loss from the accident-induced pollution of P50.1 million in 1996 was twice the actual compensation paid out to the damage claimants for the same period.

Finally, the study examined some analytical issues on the efficiency effects of alternative liability rules. It observed that while current liability policies of the government are vague in terms of the nature and extent of the liability of polluters for damages arising from injury to natural resource systems, policies on damage compensation are clear and imply that a strict liability rule is enforced on polluters. The discussion also suggested that a liability-cum- compensation policy regime may be a second-best option to address the externalities problem given the difficulties of implementing Pigovian taxes or subsidies.

The study makes the following prescriptions:

1. Guidelines for the conduct of a systematic natural resource damage assessment (NRDA) for events resulting in release of hazardous substances to the environment should be formulated. These should include the three stages in damage assessment, which are injury determination, quantification of effects, and damage determination. In the first two stages, the Philippine EIS System, which is fully institutionalized, should provide the physical, technical, and even economic data required. In the damage determination stage, the guidelines should prescribe the range of valuation methods for valuing foregone natural resource services applicable in different pollution cases.

2. Government policy on the nature and extent of liability of polluters for injury on natural resource systems should be clearly defined. Moreover, the efficiency implications of alternative liability rules should be considered in the formulation of liability-cum-compensation policies.

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Table 1. Sampling Stratification of Affected Barangays. Survey of Impact on Household Livelihood Activities. Boac , Marinduque, May - June 1997.

Barangay	No. of EGF Claimants						Total No. of Claimants	Total No. of Household
	Coastal Fishing	River Fishing	Farming (Crop Damage)	Laundry Services	FarmTrading (Loss Of Access)	Others		
Stratum I. Coastal Fishing								
1. Lupac	137		23				160	264
2. Laylay*	115						115	457
3. Maligaya	62		35				97	122
4. Tabigue	56		11	21			88	134
5. Balaring	56						56	101
6. Ihatub	45						45	188
7. Pili*	30		9				39	65
Stratum Total	**501**	**0**	**78**	**21**	**0**	**0**	**600**	**1,331**
% of Claimants	**84**	**0**	**13**	**4**	**0**	**0**	**100**	
Stratum II. River Fishing/Laundry								
1. Sawi		27	23	2		13	65	162
2. Santol		27	18	22			67	226
3. Tampus		15	18	23			56	215
4. Daypay*		21	3	2			26	61
5. Tabi		12	12	21			45	193
6. Bantad		8	7	18			33	226
7. Bamban		17	1	1		1	20	76
8. Mercado			1	17			18	229
9. Poctoy		13	8	3		3	27	60
10. Tumpon		10	9				19	23
11. Agot		10	5	3			18	88
12. Isok I				8			8	200
13. Malbog*		7		7			14	73
14. Tagwak		2	1	5			8	63
15. Agumaymayan				5			5	88
16. Isok Ii				4			4	97
17. Banbangalon		1		3			4	210
18. Matas Na Bayan				2			2	141
19. San Miguel				2			2	70
20. Murallon		1	1	1			3	115
Stratum Total	**0**	**171**	**107**	**149**	**0**	**17**	**444**	**2,616**
% of Claimants	**0**	**39**	**24**	**34**	**0**	**4**	**100**	

Table 1. (Continued)

Barangay	No. of EGF Claimants: Coastal Fishing	River Fishing	Farming (Crop Damage)	Laundry Services	Farm Trading (Loss of Access)	Others	Total No. of Claimants	Total No. of Household
Stratum III. Farming								
1. Buliasnin		9	117				126	198
2. Balogo*	49		50				99	212
3. Balimbing		16	46	8		2	72	274
4. Poras		3	39	1			43	211
5. Daig		24	24	5			53	78
6. Tanza		5	23	20			48	220
7. Bantay		1	23	4		6	34	273
8. Boton*		10	21	4			35	52
9. Mainit		7	18	2		11	38	127
10. Balagasan		13	16	2			31	140
11. Ogbac			16			2	18	79
12. Catubugan		5	12				17	108
Stratum Total	**49**	**93**	**405**	**46**	**0**	**21**	**614**	**1,972**
% of Claimants	**8**	**15**	**66**	**8**	**0**	**3**	**100**	
Stratum IV. Farming Trading								
1. Canat*					130		130	135
2. Boi					104		104	95
3. Binunga					91		91	123
4. Hinapulan			18		76		94	110
5. Bayuti*					36		36	35
Stratum Total	**0**	**0**	**18**	**0**	**437**	**0**	**455**	**498**
% of Claimants	**0**	**0**	**4**	**0**	**96**	**0**	**100**	
GRAND TOTAL	**550**	**264**	**608**	**216**	**437**	**38**	**2,113**	**6,417**
% OF CLAIMANTS	**26**	**12**	**29**	**10**	**21**	**2**	**100**	

Note: * Sample Barangay

Source of basic data: Marcopper EGF Summary Table of Economic Compensation (April-Aug. 1996),as of 10 April 1997, EGF Secretariat
1995 Census of Population, NSO

Table 2. Sample Distribution Survey of Impact on Household Livelihood Activities Boac, Marinduque, May - June 1997

Sample Barangay	No. of Households	Sample Households No.	%
Stratum I: Coastal Fishing			
Laylay	457	30	7
Pili	65	30	46
Stratum (7 Barangays)	1,331	60	4
Stratum II: River Fishing/Laundry			
Daypay	61	30	49
Malbog	73	30	41
Stratum (20 Barangays)	2,616	60	2
Stratum III: Farming			
Balogo	212	30	14
Boton	52	29	56
Stratum (12 Barangays)	1,972	59	3
Stratum IV: Farming-Trading			
Canat	135	30	22
Bayuti	35	26	74
Stratum (5 Barangays)	498	56	11
TOTAL (8 sample barangays)	**1,090**	**235**	**22**
TOTAL (44 affected barangays)	**6,417**	**235**	**4**

Source of Household Data:

1995 Census of Population, NSO.

Marcopper EGF Summary Table of Economic Compensation, 10 April 1997.

Table 3. Socioeconomic Characteristics of Sample Households Survey of Impact on Household Livelihood Activities Boac, Marinduque, May - June 1997.

Barangay	Sample Households (HH)	Ave. Age of HH Head (years)	Ave. HH Size (No. Of Persons)	Ave. Net Income (P / HH)* 1995	Ave. Net Income (P / HH)* 1996	Per Capita Net Income (P) 1995	Per Capita Net Income (P) 1996
Stratum I: Coastal Fishing							
Laylay	30	50	4	45,700	41,100	11,425	10,275
Pili	30	48	5	39,100	38,500	7,820	7,700
Stratum Sample	**60**	**49**	**5**	**42,400**	**39,800**	**8,480**	**7,960**
Stratum II: River Fishing/Laundry							
Daypay	30	48	5	30,600	26,300	6,120	5,260
Malbog	30	53	5	26,800	24,400	5,360	4,880
Stratum Sample	**60**	**51**	**5**	**28,700**	**25,350**	**5,740**	**5,070**
Stratum III: Farming							
Balogo	30	49	5	37,000	29,200	7,255	5,840
Boton	29	53	4	45,400	35,600	11,350	8,900
Stratum Sample	**59**	**51**	**5**	**41,200**	**32,400**	**9,156**	**7,200**
Stratum IV: Farming-Trading							
Canat	30	46	6	54,600	33,300	9,579	5,550
Bayuti	26	44	5	49,500	28,200	9,900	5,640
Stratum Sample	**56**	**45**	**5**	**52,050**	**30,750**	**10,410**	**6,150**
AVERAGE	**235**	**49**	**5**	**41,088**	**32,075**	**8,446**	**6,595**

*From all sources--primary and secondary occupations and income of other household members.

Source of basic data: Survey of Household Livelihood Activities, May-June 1997, REECS.

Table 4. Sample Households and Livelihoods: Affected and Unaffected Impact Survey of Household Livelihood Activities Boac, Marinduque May - June 1997

Sample Barangay	Sample HH n	No. of Affected Households By Livelihood								Total Affected HH	Total UNAFF HH
		CFS	RFS	RFM	KF	VCF	CF-M	LDY	ETC		
Stratum I: Coastal Fishing											
Laylay	30	11	1							12	18
% of n		37	3							40	60
Pili	30	13		2					2	17	13
% of n		43		7					7	57	43
Stratum II: River Fishing/Laundry											
Daypay	30		12		1	1				13	17
% of n			40		3	3				43	57
Malbog	30		12		1	2		3	1	15	15
% of n			40		3	7		10	3	50	50
Stratum III: Farming											
Balogo	30	11		15	2					21	9
% of n		37		50	7					70	30
Boton	29		14	4	7	4		2		20	9
% of n			48	14	24	14		7		69	31
Stratum IV: Farming-Trading											
Canat	30						29		2	29	1
% of n							97		7	97	3
Bayuti	26						26			26	0
% of n							100			100	0
TOTAL	**235**	**35**	**39**	**21**	**11**	**7**	**55**	**5**	**5**	**153**	**82**
% of n	100	15	17	9	5	3	23	2	2	65	35

LEGEND:

CFS = Coastal Fishing
RFS = River Fishing
RFM = Rice Farming
KF = Kangkong Farming
VCF = Vegetable/Other Crop Farming
CF-M - Crop Farming-Marketing
LDY = Laundry Services

Note: Some households in Bgy Daypay, Malbog, Balogo, Boton, and Canat have more than one affected livelihood activity; hence, the barangay totals do not tally.

Table 5. Estimated Average Foregone Income By Livelihood Activity, Boac, Marinduque, 1996.

Livelihood Activity	Households Engaged		Foregone Income (P/household)
	No.	%	
River-Based Activities			
River Fishing	39	17	5,599
Rice Farming			
Tenant	14		11,017
Farm Laborer	7	10	6,386
Land Owner	3		1,487
Crop Trading	55	23	23,093
Kangkong Farming	16	7	3,847
Vegetable & Other Crop Farming	9	4	2,932
Laundry	6	2	4,954
Non River Based Activities			
Coastal Fishing	35	15	17,938
Fish Retailing	4	2	14,540

Source: Survey of Impact on Household Livelihood Activities, Boac Marinduque, May-June 1997, REECS; 1995 Census of Population , NSO

Table 6. Estimated Total Foregone Income, Boac, Marinduque, 1996

			Foregone Income	
Barangay	Total No. of Households	% of Total Sample Households	Average (P/HH)	Total (P)
Stratum I: Coastal Fishing				
Laylay	457	40	16,447	
Pili	65	57	12,257	
Stratum Brgys	1,331	48	14,352	9,169,206
Stratum II: River Fishing/Laundry				
Daypay	61	43	10,379	
Malbog	73	50	3,822	
Stratum Brgys	2,616	46	7,101	8,544,458
Stratum III: Farming				
Balogo	212	70	21,439	
Boton	52	69	9,018	
Stratum Brgys	1,972	70	15,229	21,021,421
Stratum IV: Farming Trading				
Canat	135	97	24,982	
Bayuti	35	100	21,722	
Stratum Brgys	498	98	23,352	11,396,710
TOTAL				**50,131,795**

Source of basic data: Survey of Impact on Household Livelihood Activities, Boac, Marinduque , May-June 1997, REECS.
1995 Census of Population, NSO
Marcopper EGF Summary Table of Economic Compensation (April-August 1996, 10 April 1997), EGF Secretariat

Table 7. Present Value of Current and Future Foregone Income, Marinduque Island Mining Accident,1996-2005. Scenario A: With Short-term Rehabilitation

Year	Coastal Fishing		River Fishing		Crop Farming		Farm Trading		Total
	DC	PV	DC	PV	DC	PV	DC	PV	
1996	1.00	9,169,206	1.00	8,544,458	1.00	21,021,421	1.00	11,396,710	**50,131,795**
1997	0.60	6,378,578	1.00	9,906,618	0.70	17,060,863	0.10	1,321,358	**34,667,417**
1998	0.50	4,622,158	0.95	8,183,728	0.60	12,716,171	0.00	0	**25,522,057**
1999	0.50	4,019,268	0.95	7,116,285	0.50	9,214,617	0.00	0	**20,350,170**
2000	0.40	2,796,012	0.95	6,188,074	0.40	6,410,168	0.00	0	**15,394,254**
2001	0.40	2,431,315	0.90	5,097,727	0.30	4,180,545	0.00	0	**11,709,587**
2002	0.30	1,585,640	0.90	4,432,806	0.20	2,423,504	0.00	0	**8,441,950**
2003	0.30	1,378,818	0.80	3,426,323	0.10	1,053,697	0.00	0	**5,858,838**
2004	0.30	1,198,972	0.80	2,979,412	0.00	0	0.00	0	**4,178,384**
2005	0.30	1,042,584	0.70	2,266,944	0.00	0	0.00	0	**3,309,528**
Total		**34,622,551**		**58,142,375**		**74,080,986**		**12,718,068**	**179,563,980**

DC = Damage Coefficient

PV = P esent Value

Discount rate = 15%

(Note: At 10% discount rate, total PV is P200.0M)

Assumptions under "with short-term rehabilitation" scenario:

For coastal fishing:

1. Based on survey data, it was estimated that 40% of the motorized fishers were able to maintain their income levels a year after the spill.
2. Full recovery of the coastal area would be delayed by siltation due to the deposited tailings and by high turbidity due to rainfall during the rainy seasons in the next 6-7 years
3. The catches would reach only 70 % of pre-spill levels by the end of the 10-year period.

For river fishing:

4. Heavy rains will come during the second half of 1998. Weather conditions will return to normal in succeeding years, i.e., the dry season will not be as prolonged as in previous years, and the rainy season will bring the usual amount of rainfall to the area, i.e., no strong typhoons.
5. The movement of tailings in the river will be minimal given the natural processes.
6. Oxidation of the exposed tailings deposit on the riverbanks will be reduced by the coming of the rains. However, reduced heavy metal oxidation as a result of increased or normal rainfall would cause localized fishkills from acid drainage.
7. River system will not stabilize during the 10-year scenario period.

For crop (rice) farming:

8. Rice farming in fields irrigated by river water will not be disturbed by tailings movement and in fact will be enhanced by increased rainfall.
9. With the unclogging of the irrigation canals and the alternative water source provided by the Sawi Creek, 50% of the water requirement was achieved within two months of the accident.

For farm farming:

10. Farm trading activities in the upland areas would be back to normal in 1998. The farm-to-market roads would be once again accessible for transporting produce to the town center and lowland public markets

Table 7. (continued)

Scenario B: With Long-term Rehabilitation

Year	Coastal Fishing		River Fishing		Crop Farming		Farm Trading		Total
	DC	PV	DC	PV	DC	PV	DC	PV	
1996	1.00	9,169,206	1.00	8,544,458	1.00	21,021,421	1.00	11,396,710	**50,131,795**
1997	0.60	6,378,578	1.00	9,906,618	0.70	17,060,863	0.10	1,321,358	**34,667,417**
1998	0.50	4,622,158	0.95	8,183,728	0.60	12,716,171	0.00	0	**25,522,057**
1999	0.60	4,823,121	0.95	7,116,285	0.50	9,214,617	0.00	0	**21,154,023**
2000	0.60	4,194,019	0.95	6,188,074	0.30	4,807,626	0.00	0	**15,189,719**
2001	0.30	1,823,486	0.80	4,531,313	0.10	1,393,515	0.00	0	**7,748,314**
2002	0.10	528,547	0.70	3,447,738	0.00	0	0.00	0	**3,976,285**
2003	0.00	0	0.50	2,141,452	0.00	0	0.00	0	**2,141,452**
2004	0.00	0	0.30	1,117,279	0.00	0	0.00	0	**1,117,279**
2005	0.00	0	0.15	485,774	0.00	0	0.00	0	**485,774**
Total		**31,539,115**		**51,662,719**		**66,214,213**		**12,718,068**	**162,134,115**

DC = Damage Coefficient
PV = Present Value
Discount rate = 15%
(Note: At 10% discount rate, total PV is P177.0 M)

Assumptions under the "with long-term rehabilitation" scenario:

1. The transport of the remaining tailings in the Boac River into the ocean thru "managed submarine placement" rehabilitation option will commence in 1999 and will be completed by beginning of 2001.
2. The river system will start stabilizing once the deposited tailings have been totally removed. However, the natural productivity of the river in terms of fish and other aquatic organisms, will be achieved only gradually.
3. For coastal fishing, damages will increase slightly during the two-year implementation of the long-term rehabilitation activities, after which damage will decline substantially; pre-spill condition will be achieved by year 2003.
4. For river fishing, the long-term rehabilitation will not bring full recovery within the 10-year period but an 80% recovery is assumed
5. For crop farming, the construction of small water impoundment dam projects midway in the 10-year period to offset the El Niño drought will ensure adequate and regular irrigation water supply by the year 2002.

Table 8. Lost Economic Values From River-Based Recreation in Boac River, Boac, Marinduque, 1996.

Recreational Activity by Barangay	HH Engaged No.	HH Engaged %	Average time spent (days/HH)	Lost Economic Value (P)
Swimming				
Malbog	21	70	28	42,924
Daypay	26	21	21	33,434
Boton	27	25	25	35,100
Total				***111,458***
Fishing				
Malbog	4	11	11	3,132
Daypay	6	9	9	3,440
Boton	4	8	8	1,747
Total				***8,319***
Grand Total				**119,777**

Assumption:

1. Value of recreation time = 20% of wage rate adjusted for unemployment.

Table 9. Opportunity Cost of Fetching Drinking Water from Alternative Sources Boac, Marinduque, 1996

Barangay	HH Engaged	% No.	Average additional time spent (days/HH)	Opportunity Cost (P)
Balogo	1	3.3	3	3,148
Boton	17	59	6	28,532
Canat	1	3.3	27	18,043
Total				**49,723**

Assumption:

1. The minimum wage rate adjusted for unemployment was used to value the additional time spent fetching drinking water from alternative sources.

Table 10. Number of Households Reporting Illness from Exposure to Boac River and Coastal Waters. Boac Marinduque, 1996.

	Laylay (n=12)	Pili (n=7)	Daypay (n=10)	Malbog (n=10)	Balogo (n=6)	Boton (n=9)	Canat (n=10)	Bayuti (n=5)	Total
Upper respiratory illness	1	-	-	6	1	7	2	2	19
Loss of appetite and weight	-	1	-	-	-	3	1	-	5
Anemia (general body weakness)	-	5	-	-	-	-	1	-	6
Stomach pains and disturbance	8	5	5	5	5	4	8	2	42
Skin disease	8	-	10	7	6	8	9	4	52
Dizziness	-	-	-	-	1	1	3	2	7
Headaches	-	-	5	1	1	2	4	3	16
Cancer	-	1	-	-	1	1	-	-	3
Paralysis	-	-	-	-	-	-	-	-	-
Others	-	1	-	-	2	-	-	1	4

Note: (-) is zero

Table 11. Number of Households Adopting Mitigation Measures to Avoid Exposure to Mine Tailings. Boac, Marinduque, 1996.

	Laylay (n=12)	Pili (n=7)	Daypay (n=10)	Malbog (n=10)	Balogo (n=6)	Boton (n=9)	Canat (n=10)	Bayuti (n=5)	Total
Stopped bathing in the river	3	1	10	9	1	8	5	-	37
Stopped swimming in the river/coastal waters	7	4	3	6	3	7	3	-	33
Did not eat fish from the river/coastal waters anomer	9	5	1	6	4	5	4	-	34
Washed clothes elsewhere	-	-	4	6	1	7	5	-	23
Watered/bathe farm animals elsewhere	-	-	-	2	-	-	1	-	3
Fetched drinking water farther	-	-	-	1	-	7	1	-	9
Purchased bottled water	-	-	-	-	-	-	1	-	1
Boiled drinking water	4	2	-	3	3	1	-	-	13
Others	1	-	-	-	-	-	-	-	1

1. n = number of households who reported they perceived that exposure to mine tailings posed health risk.
2. For Laylay and Pili, exposure was to mine tailings in coastal waters, the rest were to mine tailings in Boac River.

Note: (-) is zero

Table 12. Institution Related Issues. Boac, Marinduque, 1996.

Issue/No. of HH Reporting	Laylay	Pili	Daypay	Malbog	Balogo	Boton	Canat	Bayuti	Total No.	Total %
All Households	**n=30**	**n=30**	**n=30**	**n=30**	**n=30**	**n=29**	**n=30**	**n=26**	**n=235**	
1. No knowledge of EGF	29	26	22	25	28	27	24	20	201	**86**
2. Non-resumption by govt. of MMC project	23	29	26	27	25	29	24	15	198	**84**
Affected Households	**n=17**	**n=17**	**n=13**	**n=15**	**n=21**	**n=21**	**n=29**	**n=26**	**n=125**	
3. Inadequate compensation	9	13	15	11	4	21	25	16	114	**91**
4. Long processing time	6	10	11	9	3	20	23	19	101	**81**
4. Minimal or no expense	3	8	13	12	3	19	14	10	82	**66**

Table 13. Tailings rehabilitation options: Dredging of Boac River.

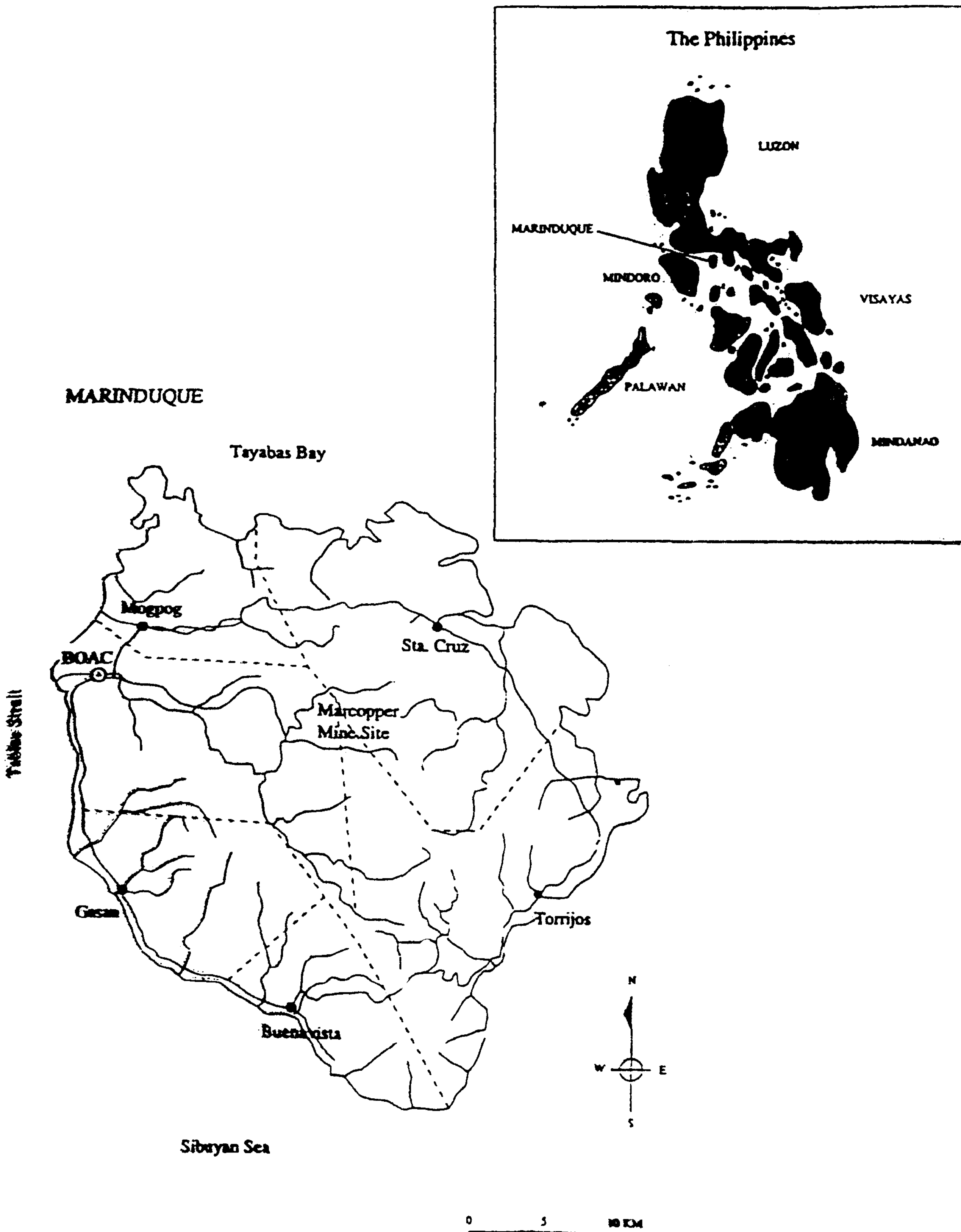
	ESTIMATED COST	SOCIAL COST	ENVIRONMENTAL COST	TIMING
LANDFILL	US$ 5 - 10 M	• Extensive relocation • Area of 200 ha • Agricultural land lost	• Requires access roads to river • Oxidation-capping required • Land Area • Possible effect on Groundwater • Stability in high rainfall needed	• 1.5 years
HAUL TO TAPIAN	US$ 10 -15M	• Relocation • Area of 30 ha	• Long access roads needed • Large vehicles disturbing the river for 3 years • Difficult to clean all areas • Needs multiple access points	• 3 years
PUMP	US$ 15 - 20M	• Dam(s) in river • Pipe Access • Power Route	• Potential for overtopping dams • River disturbance for at least 1 year • Requires dredging or capture	• 2 years
COASTAL RECLAIM	US $ 50m	• Positive Asset • Area of 550 ha • Pipeline needed for Tapian	• Unknown effects on fish resource • Large area affected • Tidal zones sterilized • Oxidation may occur • Difficult to stabilize • Requires dredging or capture	• Not immediate • Waiting Tapian tailings • 15 years
SETTLING BASIN	US$ 8M	• Relocation of delta • Agricultural and lost area of 250 ha	• No oxidation if totally submerged • Large area affected • Requires dredgate disposal area • Possibility for remobilization in floods • Possible effect on estuary	• 6 months
DEEP OCEAN -Settling -River	US$ 13M US$ 8M	• Agricultural land lost minimal	• Cannot be reclaimed if problems arise • Lowest impact on land • Requires dredging or capture • No oxidation • Appropriate site required	• 1 year • 2 years
DREDGE CHANNEL	US$ 5M	• Relocation of delta • Agricultural land lost • Effects on fishermen	• Area of 100 ha • Excavation art estuary • No. oxidation if underwater • Requires natural transport • Effects on groundwater • Requires dredgate disposal area	• 6 months

Source: Marcopper/PDTS 1996

Table 14. Executive Summary of Marcopper Environmental Guarantee Fund.

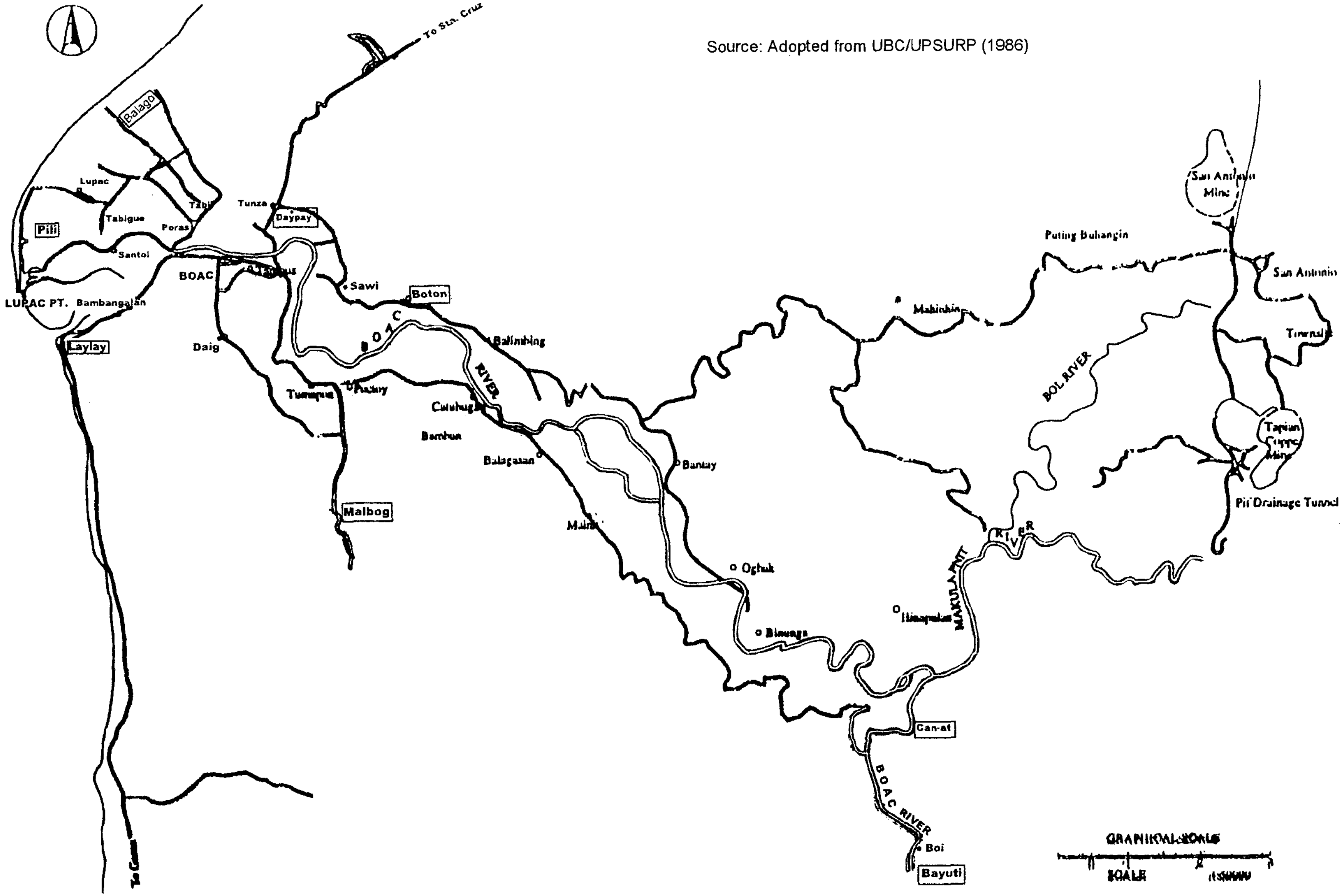
			Claimant			
Initial Fund Available , 17 April 1996					P	5,179,334
Total Amount Replenished as of Feb. 1998						25,218,168
Total Disbursed from Fund as of 28 Feb. 1998						29,939,595
Economic Compensation						
Fishermen	sea	-	564	6,428,392		
	river	-	264	2,942,030		
Farmers			396	2,311,751		
Laundrywomen			234	2,147,008		
Traders (loss of access)			506	3,728,504		
Mansabang Irrigators Association			1,528	3,316,720		
Others			43	701,409		
Total - Economic Compensation			3,535			21,575,814
Relocation Projects						
Corehouses - (Ind.- 126, Evc. -18)			144	4,860,980		
Evacuation Centers			16	1,825,890		
Moving Assistance			20	720,438		
Total Relocation Projects						7,406,418
Administrative Cost						957,363
Amount of Checks for Signature, 28 Feb. 1998						1,310,440
Total Amount Made Available (including Interest on Savings Account)						30,397,502

Source: MMC, 1998 (As is).



Map 1. Marinduque in the Philippines

Source: Adopted from UBC/UPSURP (1986)



Map 2. Barangays along the Boac and Makulapnit Rivers and coastal areas

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