DECISION MAKING TO PRIORITIZE MINE CLEARANCE PROJECTS

IN SUPPORT OF THE U.S. DEPARTMENT OF STATE STRATEGIC PLAN AND NATIONAL POLICY GUIDANCE

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EXECUTIVE SUMMARY

In 2003-2004, the Mine Action Information Center (MAIC) was tasked by the US Department of State (DOS) Office of Weapons Removal and Abatement (WRA) with performing a cost-benefit analysis (CBA) of two demining programs. This analysis was used to develop a model to analyze the quantitative impacts, expected results, and suggested prioritization of mine clearance activities. Prioritization was considered within the context of socio-economic development programs.

The study team conducted a review of the extant literature, conducted face-to-face and telephone interviews with experts, and identified key factors to be considered. The following findings were emphasized in this research:

- Risk reduction rather than socio-economic considerations drive decisions concerning mine action.
- Where risk is identified, clearance is the activity emphasized.
- Funds for mine action flow separately from other development funds and there is little coordination between decision makers in the mine action community and those in the development community.
- Decisions concerning where to clear are supply driven.
- Insufficient attention is paid to the likelihood that the intended benefits (beyond risk reduction) of mine action will be realized.
- Cost-benefit analysis is a useful tool for decision making concerning mine action but may be inadequate when used alone in situations where there are data collection problems and where intangibles are of particular importance.

A theoretical cost-benefit model was built on the basis of the research phase. Potential costs and benefits were identified and possible data sources were uncovered. A research protocol was developed for in-country data collection. In order to factor in the contributions of intangible benefits, the team researched decision-making processes other than cost-benefit analysis. The study team identified a multi-criteria decision making process to test as a possible addition to standard cost-benefit analysis.

In consultation with WRA, the team chose two mine-affected countries, Thailand and Ethiopia for data collection and study. In-country liaisons were identified and permission to study mine action was secured from the mine action centers in each country. In late spring and summer of 2003, the team performed a site visit. In each country two projects were chosen for comparison using CBA and data were collected. The CBA model was run using these data and results analyzed. Additionally the analytical hierarchy process (AHP) was applied to the same

projects. Criteria important to prioritizing projects on the basis of their respective contributions to socio-economic development were identified and assessed.

The study demonstrates that cost-benefit analysis is an effective tool for increasing transparency and for addressing tangible socio-economic benefits. However, contextual factors and intangible concerns should also be taken into account in many situations. This is especially true if the benefits of saving lives are not to be included in the quantitative analysis and where no single project is clearly preferred above others on important intangibles. Under these circumstances combining CBA and AHP yields results that are collaborative and transparent. Specific recommendations follow.

- Assign socio-economic concerns a larger role in prioritization once the immediate post-conflict period is over and risk reduction is no longer as crucial.
- Recognize mine action as a development activity. Mine action funds should be mainstreamed.
- Adopt a decision-making procedure that is transparent and collaborative.
- Include development planners and local constituencies early in the decision making process.
- Consider alternatives to clearance where benefits are unlikely to exceed costs and where intangibles do not support clearance in spite of costs.
- Consider enlarging the Freeways decision tool to include socio-economic considerations.
- Imbed flexibility in any decision-making tool adopted.

INTRODUCTION

In spite of the relatively large amounts of money dedicated to mine action activities around the world, relatively little direct attention has been paid to the socio-economic costs and benefits of landmines. Instead, the emphasis of mine action programs has been placed on risk reduction and on regaining access to resources needed by communities. Over the last few years, increasing attention is being devoted to ways to assess the socio-economic impact of landmines. The limited resources available to mine action and the extent of the problem call for ways to prioritize among potential projects and also to measure trade-offs between clearance and other solutions to contamination.

Mine action has direct impacts on the lives of people in affected communities. Not only does it bring increased security, but also it provides opportunities for the productive use of reclaimed land, for the settlement of displaced persons, for improved access to infrastructure and resources, and for numerous downstream economic benefits. Mine action is a development activity although it is often not thought of in those terms. With proper socio-economic analysis, we can choose the projects that will provide the most benefits. Doing so requires large amounts of information, consideration of contextual factors, collaboration among mine action personnel and development planners, and the use of systematic decision making tools.

Several problems face planners and decision makers in attempting to carry out this task. A serious problem is a lack of information about the socio-economic effects of mine action and difficulty in securing hard data. Data is lacking to measure the assumed benefits of mine action as well as the costs. As a result, researchers have called for continuous information collection to aid in evaluating mine action tasks in terms of the socio-economic benefit (Byrd and Gildestad 2001). Additionally potential indirect and long-term benefits of mine action may be hard to isolate and measure directly. As people return to areas of cleared land, new housing may be constructed; schools may be built and teachers hired; roads may be built making it easier to get goods to market; farmers may purchase agricultural inputs; taxes will be collected; local and export markets may be developed, and so forth. Some of these benefits may be directly attributable to mine action programs, others only partially so. Mine action may also have multiplier effects for activity already occurring but these are impossible to quantify. Another serious problem is the importance of context. Projects in different countries may have very different effects and solutions need to be tailored to the community. This in turn means that local communities should be included in the decision making process at some level.

The Mine Action Information Center (MAIC) was tasked by the United States Department of State with performing a cost-benefit analysis of two demining programs to be used to develop a model to analyze the quantitative impacts,

expected results, and suggested prioritization of mine clearance activities. Prioritization was to be accomplished within the context of socio-economic development programs.

PROJECT METHODOLOGY

The MAIC team consisted of Dr. Kay Knickrehm and Ms Donna Stewart. Dr. Suzanne Fiederlein served as liaison and coordinator with the MAIC and the contractors at the Department of State. The MAIC team surveyed the extant literature, searched official data sources, and interviewed experts in the field. Once a set of potential costs and benefits were assembled, the MAIC team chose two mine-affected countries for data collection: Thailand and Ethiopia. Field research was conducted in these two countries. Two projects were selected in each country for comparative purposes. Data collected from these activities were used to finalize a model for cost-benefit analysis and to identify data problems and analytical concerns – primarily how intangibles and context specific issues might be addressed. A multi-criteria analysis tool as an alternative to standard cost-benefit analysis was developed to address some of these concerns. These activities are discussed in slightly more detail below.

In the first phase of the project the study team reviewed publicly available documents and studies from official, academic and NGO sources (see bibliography). This desk study of the literature was accomplished using library research, internet searches, and contacting individuals in the mine action and development communities to solicit suggestions for relevant literature.

In the course of reviewing relevant information the team interviewed knowledgeable people in the fields of demining, economics and decision-making methodologies. The team traveled to the World Bank headquarters in Washington to meet with persons responsible for planning and implementing a loan to Ethiopia for the purposes of demining. This represents the first such activity on the part of the Bank. Another day in Washington was spent with Bob Eaton and Mike Kendellen at the Survey Action Center. We met with Alistair McAslan at MAIC to talk to him about Cranfield University's Freeway decision-making system. Two days were spent with Ted Paterson to discuss prioritizing mine action programs based on socio-economic concerns. A complete list of those interviewed in Phase I of the project includes:

- Mr. Ted Paterson an economist, co-author of GICHD study and independent consultant.
- Mr. Emmanuel Dessier, an economist who was at that time serving as the World Bank liaison to the Ministry of Finance and Economic

Development in Ethiopia overseeing WB loan for mine clearance in Tigray.

- Mr. Alistair McAslan, Director, Cranfield Mine Action Unit, Cranfield University, United Kingdom
- Mr. David McCracken, engineer and consultant in mine action, experienced in mine clearance projects globally but particularly with the Thai Mine Action Center.
- Mr. Bob Eaton, Director, Survey Action Center.
- Mr. Mike Kendallen, Associate, Survey Action Center.
- Dr. Bruce Brunton, an economist at James Madison University specializing in development economics.
- Dr. Susan Palocsy, a professor of Information Technology and Management Science Program at James Madison University.

These activities provided general background information on mine action programs, the role of the Landmine Impact Survey, (LIS) and decision-making practices and techniques.

On the basis of these activities, the team moved into the second phase of the project. During this time we outlined potential costs and benefits to be included in the study. Although tasked specifically to develop a cost-benefit model, it became apparent early in the literature review that cost-benefit analysis (CBA) presents great challenges for studying mine action. Ted Paterson in particular was skeptical about using CBA to prioritize programs and suggested we look into multi-criteria analysis. As a result the team also began to investigate other decision-making methodologies. A technique used extensively in business applications and also by the U.S. military, the analytic hierarchy process (AHP), was chosen. AHP can be used without sophisticated software (although such software is available) and can be easily understood without formal training.

Thailand and Ethiopia were chosen as case studies, and the third phase involved setting up and completing visits to these countries. In each country local coordinators were chosen to assist with trip logistics, interpreting where necessary and facilitating data collection. In Thailand, the coordinator was Ms Tui Chalermluck. Mr. Dave McCracken also assisted the team. Both of these individuals have worked in the Thai mine action community and also in development activities. In Ethiopia, Ms Azeb Gelaye was hired to coordinate that visit. Ms Gelaye is working for Norwegian People's Aid (NPA) in conducting the Landmine Impact Survey which is underway at this time. She was granted leave from NPA for the study team's visitation period. Ms Gelaye is a nurse who has

worked in other African countries on development projects. The team's visit was also facilitated by Mr. Emmanuel Dessier, the World Bank's liaison to the mine action program in Ethiopia and by NPA. The team received approval from the governments of these two countries in advance to conduct the study. The team spent approximately one week in each country. Within each country two demining projects were chosen for comparative purposes.

The data collected was used to build and test the CBA model. Considerable time was spent refining the model based on the data. The field trips also helped the team to identify intangibles important to the success of the mine clearance projects. These were incorporated into the AHP model, in addition to quantitative factors.

BACKGROUND

In reviewing the literature and in our interviews, the study team found considerable support for building a prioritization model incorporating socio-economic factors. Earlier studies by the Geneva International Centre for Humanitarian Demining and the World Bank emphasized the need to go forward in this area. In meeting with officials at the World Bank, we were also strongly encouraged. In September, we were invited to participate in a symposium at the Bank to discuss what we were doing with other organizations engaged in data studies relevant to development.[1] Great interest was expressed on the part of the other participants at this event.

From our review of the literatures and interviews, we drew a number of conclusions important to building our model.[2] These are discussed briefly below.

Research Conclusions

First, where contamination is identified, clearance is the activity that is emphasized. Clearly complete clearance is not a viable solution to the global landmine problem (Benini 2002). In order for informed decisions concerning prioritization to be made, economic factors as well as risk reduction concerns must be considered. There are gains to be made between surveying and marking on the one hand and clearance on the other. It may be more cost effective in some areas to move populations. Many factors affecting these decisions will vary from country to country and from region to region within countries. Establishing a clear indication of costs and potential benefits can help in making these decisions. Additionally the work now being done at the Survey Action Center (SAC) in terms of identifying the point at which clearance produces diminishing returns will also prove helpful.

[1] The symposium , "A Dialogue on Disability Caused by Conflict: How to Optimize Synergies with External Partners", was organized by the World Bank Office of the Advisor for Disability and Development. It was held September 24, 2003.

[2] Although some specific citations are given below, the conclusions are drawn from a combination of reading and interviews. The bibliography lists all those sources that contributed to our overall conclusions and to the model building.

Second, donor aid for mine action projects tends to flow separately from other development funds. Decisions concerning priority setting are made separately for these streams of resources and with little collaboration and consultation among decision makers involved in different activities. Decisions about where to concentrate mine action are made with minimal or no contact with development managers. Funds for allocation to different functional areas (clearance, mine risk education, and victim assistance) and decisions concerning spatial allocation may come from different sources and involve different authorities. Meanwhile development decisions are made without consideration of landmine issues. Policy makers and other government officials outside the mine action community consider landmines only when they directly conflict with other projects (GICHD 2001, 5). (In fact during the study team's field visit to Thailand numerous officials in government agencies expressed surprise upon learning that there are landmines in that country.) Nevertheless mine action is a development activity. Those saved from injury and death from landmines are able to live out economically productive lives; land is brought back into productive use; and access to infrastructure is reopened.

Third, often decision making concerning mine action tends to be supply driven – decisions as to priorities and methods are made on the basis of where and what kind of donor money is available, what equipment is available and where this equipment is located, and where trained clearance teams exist. Decision-making is not transparent and may be made without knowledge of local conditions. Demand led decision making should integrate mine action into overall development planning and tie it to local area needs.

Fourth, risk reduction is the driving force behind the prioritization of activities. In those countries where there is a Landmine Impact Survey (LIS) communities are assigned a mine impact score. Casualties heavily influence this score. Populations are most vulnerable to injury in the immediate post-conflict period when displaced persons are returning and the location of hazards is unknown. Thus in the immediate post-conflict period risk reduction may be the most appropriate consideration, but over the long term, the accident rate generally goes down and development concerns should start to play a larger role in decisions making. (GICHD 2001, 6).

Fifth, attention must be paid to the likelihood that cleared land will realize its intended use. Clearing land can have unintended consequences. For example in some areas cleared land becomes attractive enough that officials take it away from peasants. In other instances land has been cleared but other safety concerns have kept people from returning to it. Additionally farmers may not possess the resources that they need to use the land once it is available. If demining decisions are made in consultation with development planners, then these problems can be avoided. Coordinated efforts can insure that farmers will be able to return the land to productive use. (Sekkenes 2000).

Decision Making Tools

This section provides an overview of two commonly used decision making tools. The team reviewed a number of decision-making tools (see bibliography). Different methods of conducting cost-benefit analysis, its usefulness and its disadvantages were studied to choose the best CBA approach. Several multi-criteria approaches were also examined and the analytic hierarchy process was chosen for consideration. Each of these techniques is briefly described below. In the next section, the particular models adapted to prioritizing mine action programs are presented.

Cost Benefit Analysis. Cost-benefit analysis is a tool used to plan programs and evaluate outcomes. In standard cost-benefit analysis, the negative impacts (costs) are compared to positive impacts (benefits) to determine the net benefit (costs minus benefits). Discounting is used to incorporate the effect of time on both costs and benefits. Discounting is derived from the theory that people will not pay as much for something that will not be available until a future date. Discounting is accomplished using present value. The formula for calculating present value is

$$\text{PV}=\frac{FV}{(1+d)^t}$$

where PV is the present value of the future benefit, FV is the stated value of the future benefit, d is the discount rate, and t is the number of years. Clearly the discount rate chosen is crucial for results, and economists do not agree on the social discount rate. A lower discount rate favors projects that occur farther into the future. Some economists have argued for low discount rates for government funded projects because the government should serve as a trustee for future generations. Others favor higher rates on the argument that this will insure that opportunity costs will be considered (Sylvia 1997).

The most common way to compare the costs and benefits is by computing the net present value (NPV) which is total discounted benefits minus total discounted costs. A positive NPV is said to return benefits. Sensitivity analysis refines cost-benefit assessments.

Cost-benefit analysis gives decision makers a tool for decision-making that makes the process more transparent. Problems with the technique center on its inability to effectively consider intangible costs and benefits as well as its substitution of the judgments of experts for the political process (Sylvia 1997).

Some studies have applied cost-benefit analysis as a method of investigating the relationship between demining and socio-economic factors. The Geneva International Centre for Humanitarian Demining (GICHD) performed analyses of demining programs in Laos and Mozambique. Only those benefits associated with

livelihood were included (2001). No attempt was made to assess the economic value of lives saved.

Using straight CBA, benefits exceed costs in Laos but not in Mozambique. In part this finding is due to land scarcity in Laos and because farmers in Mozambique receive a very low proportion of the retail price for their crops. Finally retail prices are depressed in Mozambique. Nevertheless the authors suggest conditions under which mine clearance operations in Mozambique can be financially justified. Although overall there is land abundance in Mozambique, certain types of families are land-poor and are subject to food insecurity. Additionally mines block access to water in some areas significantly increasing the workload of women. Targeting those blockages that increase the demand's on women's time results in projects with a positive benefit-cost ratio. The GICHD study illustrates the usefulness and feasibility of CBA applied to mine action but also effectively illustrates its shortcomings in the absence of detailed local information and considerations for non-tangible benefits.

Probably the most extensive cost-benefit analysis of mine action is the study of programs in Afghanistan by William A. Byrd and Bjorn Gildestad for the World Bank (2001). They divide the socio-economic costs of landmines into three broad categories: loss of life, denial of access to mine-infested land and distortion of behavior such as more time spent in travel or decisions to forgo journeys due to the existence of mines. They perform eight regional case studies intended to be representative of most of the agricultural land.

The authors find that the Mine Action Program for Afghanistan generates substantial benefits. Clearance using dog teams is the overall best method. The authors emphasize the importance of flexibility in applying CBA to different areas, taking into account local conditions. They recommend greater community participation in the planning and prioritization of mine clearance activities to complement CBA, particularly in terms of determining the probability that cleared land will be returned to productive use. Byrd and Gildestad note problems with the availability and quality of data. Their study indicates the extensive fieldwork necessary to obtain reliable data and the importance of considering local context.

A cost-benefit analysis of United States demining programs in Ethiopia and Eritrea was conducted for the period 1993-1995 (Litzelman 2002). Primary benefits included lives saved and medical costs saved. For the productivity value of lives saved Litzelman uses Ethiopia's GDP per capita. The value of cultivable land and grazing land restored and livestock saved were considered secondary benefits. The author addresses the absence of data in some areas by making estimates based on data available from Mozambique. The author considered three different discount rates for benefits. To calculate net benefits Litzelman uses the total costs for FY93-95. These are not discounted. Regardless of discount rate used, he finds that clearance does not yield a favorable cost-benefit ratio. The author concludes that demining is not an appropriate subject for cost-benefit analysis because it cannot consider the non-quantifiable benefits to the United States including such things as

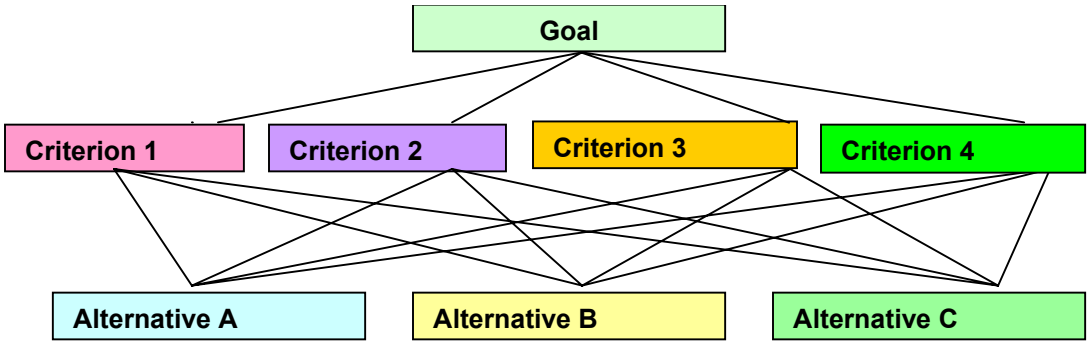
strengthening U.S. relations with the countries in question, promoting regional stability, providing a training benefit for .S. troops and increasing troop morale.

These projects suggest that standard CBA can be used to evaluate ongoing mine action projects to determine whether purely economic benefits outweigh costs. These studies also show that benefits do outweigh costs under some circumstances and this is valuable information. However they also indicate that there are data collection problems. The most thorough of these studies (Byrd and Gildestad) represents an enormous undertaking in terms of collecting the data necessary. In situations where CBA is going to be used to prioritize projects not yet undertaken, collecting this kind of data is not feasible.

Additionally these projects suggest that local conditions and intangibles may be important considerations in choosing projects. Given these concerns the search team examined the decision-making literature to evaluate other models for prioritization. The simplest and most common is the analytic hierarchy process (AHP).

Analytic Hierarchy Process. The analytic hierarchy process (AHP) is a decision-making method that allows for the consideration of both quantifiable and non-quantifiable benefits and costs. It is used extensively in business applications but has been less often used in the social sciences or in government. AHP breaks a problem down into a series of sub problems to provide a relative ranking of alternatives. The technique is based on the assumption that humans possess an innate ability to make sound judgments about small problems (Saaty 1994). Hard data may be used where available, but expert judgments may be used in place of missing data. The process is collaborative and facilitates input from different levels of administrators.

Figure 1 AHP Hierarchy



In AHP a problem is modeled in a hierarchy consisting of the main goal, criteria thought to be important to that goal, and alternatives for satisfying those criteria. See Figure 1. This illustration contains just three levels but more levels can be added as necessary. Starting in the lowest level in Figure 1, pairwise comparisons

Table 1
Pairwise Comparison Scale

Scale	Interpretation
1	Equal importance/preference of both elements
3	Moderate importance/preference of one element over another
5	Strong importance/preference of one element over another
7	Very strong importance/preference of one element over another
9	Extreme importance/preference of one element over another
2,4,6,8	Intermediate values

Source: Gass, *Linear Programming: Methods and Applications,* McGraw-Hill, New York, 1985.

of the elements are made with respect to each element in the next highest level. A sample pairwise comparison scale is presented in Table 1.

The pairwise comparisons are recorded in a matrix for each criterion. Table 2. represents a hypothetical table comparing alternatives A and B on a single criterion. The preferred option is in the rows (i.e. B is strongly preferred to A and moderately preferred to C). The reciprocal of each comparison is automatically entered for the less preferred option. To normalize them, the scores are summed for each column and each score is then divided by its column total. Next the average is computed across rows. This process is repeated with pairwise comparisons of the criteria to evaluate their relative importance to the overall goal. In the final steps of the methodology, the overall ranking of the alternatives is determined based on the relative weights of the criteria and the priorities of each alternative for each criterion.

Table 2.
Hypothetical Pairwise Comparison

	A	B	C
A	1	1/5	1/2
B	5	1	3
C	2	1/3	1

AHP has been used extensively for business and government applications. Where hard data are available; the process can use those data to assign preferences, where data are missing, expert judgments can be used. The model can accommodate both tangible and intangible costs and benefits.

Freeway is a strategic planning tool that allows mine action professionals to assess the most cost effective means of mine clearance for different terrains (Cranfield Mine Action 2003). It also provides insight into the scale and likely duration of mine clearance. Freeway does not include socio-economic factors in its analysis at this time although it is considered as a next step.

FIELD RESEARCH

On the basis of the research described above, the study team built a theoretical cost-benefit model and an AHP model to be applied to mine clearance programs. To further develop and refine these models the MAIC team chose two mine-affected countries, Thailand and Ethiopia. The project was originally developed with the Thai program in mind. Thailand represents a country removed in time from conflict with a mature mine action program. The Thai Mine Action Centre (TMAC) was interested in participating in the project and was very accommodating to the study team. The team also had some knowledge of the Thai program from a previous site visit and had worked with people in Thailand including Dave McCracken and Tui Chalermluck who have both worked with TMAC. In meetings with the DOS Office of Weapons Removal and Abatement (WRA) the study team considered sites for the second case. Ethiopia was chosen for its contrasts with Thailand. It is a country where conflict has only recently abated. It is less developed than Thailand and its mine action program is relatively new and at the time of the field visit its LIS was not yet completed. The involvement of the World Bank in the demining program has created opportunities for coordination between development and mine action officials. Mr. Emmanuel Dessier, World Bank representative in Ethiopia working with the mine action program, agreed to help the study team obtain the necessary permission to study the Ethiopian program.

In both instances the MAIC team received approval from the mine action centers and in the case of Ethiopia, also sought and received support from the United Nations mine office and from the Ministry for Finance and Economic Development. A data collection protocol was developed in consultation with in-country liaisons.

Constraints limited time in each country to slightly more than a week, so identifying individuals in each country that could set things up in advance and continue to provide support after we left was imperative. Trustworthy contacts in both Thailand and Ethiopia made the short visits possible.

Thailand

Background. Landmines affect 18 provinces in Thailand in an area that comprises about 796 square kilometers of land. Mines are most heavily concentrated in seven provinces lining the Thai-Cambodian border. From 1979 to 1998, the Thai-Cambodian border experienced intense conflict. The combatants used landmines primarily to prevent the movement of people in and out of Cambodia. Mines were laid by the Cambodian Peoples' Armed Forces and the supporting Vietnamese Army as well as by Cambodian resistance groups.

Mines were also laid along the Laotian and Burmese borders. From 1964 to 1989, conflict occurred along the Laos border between the Thai Communist Party (TCP) and the Royal Thai Army. Landmines and booby-traps were used as principal

weapons by both sides. These weapons were used in border passages to restrict movement and as protection around guerilla and government military bases.

Fighting among resistance groups and the Myanmar government continues today in Burma's border areas, frequently spilling over into Thai territory. There have been frequent clashes in the border areas opposite Kanchantaburi, Ratchaburi, Tak, Mae Hong Song, and Chiang Mai provinces. As in other border conflicts, mines produced in Myanmar are used to deny access to both border passes and residential areas. With military conflicts raging on, high numbers of ethnic minorities fled to Thailand for safety. Many of these refugees, along with animals such as elephants, have become casualties of mines. In addition, mines and improvised devices are causing casualties in Thai agricultural areas, seriously affecting farming communities. Although the Thai military no longer uses landmines, the proliferation of landmines along the Thai-Burma border continues. Myanmar troops and Burmese refugees on the border often lay new mines. An estimated 100,000 mines exist across the country as a whole, according to the Landmine Monitor Report 2000.

The Royal Thai Army began demining in 1987. In August 1998, the Prime Minister of Thailand formed the National Mine Action Committee (NMAC). The prime minister directs and chairs NMAC, which was formed to address landmine issues. NMAC membership consists of all major government ministries and departments of the Royal Thai Government.

NMAC established the Thailand Mine Action Center (TMAC) on January 18, 1999. TMAC serves as the central control over all anti-personnel landmine issues and operations in Thailand. TMAC also serves as the center for the full range of mine action issues in Thailand, including coordination with all international organizations and donors. TMAC is responsible for preparing and coordinating the implementation of a national mine clearance plan. Thailand developed an initial "Master Plan on Humanitarian Mine Action of Thailand" for a four-year period (2000-2004). Seven Humanitarian Mine Action Units (HMAUs), each with 99 personnel, will be established along the problem borders. TMAC has trained personnel to work in the HMAUs. HMAU #1 HQ, which was partially supported by U.S. contributions to the FY2001 program, is deployed at Wattana Nakon, Sa Kaeo province. This demining unit includes a mine awareness team, technical survey team, mine detection dog (MDD) team, manual demining team and a mechanical assistance team. The units are stationed in Ban Nong Ya Kaeo on the Thai-Cambodian border. The duties of each HMAU include local coordination of mine action activities such as public relations, mine awareness, information collection, technical survey and demining.

Data Collection.

The MAIC team visited Thailand May 31- June 8. In Thailand the team received a briefing from Dave McCracken, Technical Advisor to TMAC which gave an

overview of the Thai program. Two projects were chosen for comparison. In Sa Kaeo province, houses have been built for 210 farm families each on one rai (Thai basic land unit). After clearance each family will receive 14 rai. In Chantarburi province a plot of 32 rai are being cleared for a market.

The team met with General Gitti Suksomstarn, head of TMAC and spoke with him about prioritization for mine clearance. Currently TMAC makes clearance decisions based on their five-year plan. A major concern in prioritizing projects is risk reduction. Additionally projects are chosen that have the potential to be completed within the allotted time frame. In part this means that plots that are easier to clear are chosen first. Projects are chosen in cooperation with provincial officials. However the border area is controlled by the military and the military decides under what conditions it is settled. Currently the "self-defense" villages are being established in the contaminated areas. Once villagers are trained, the military will withdraw, however villagers will not own title to land received.

At the TMAC office the team talked with statisticians concerning the data. We received the LIS data and also GIS data for the projects we are examining. We discussed the difficulty of securing good victim data. When a mine victim goes to a hospital, he or she is reported as an "accident". The cause of the accident is not recorded. Additionally the victim's home is recorded but where the accident actually occurred is not. Thus it is very hard to get accurate data on victims. In areas where there are clearance teams there has been some success at getting the hospitals to record the cause of the accident. Also because the mine action unit usually has the nearest ambulance, they are often the ones to transport victims to hospitals and can report incidences themselves. Nevertheless, except for the two year period covered by the LIS, victim data is unreliable.

To collect statistics on livelihood and demographics we visited a number of government offices. Among those visited were:

- Mr. Wilas Suwee, Director, Statistical Forecasting Bureau, and Mr. Ruamporn Sirirattrakul, Chief, Economic Statistics Analyzing and Forecasting Group

- Mr. Sahasa Nilaphan, Director, Office of Soil Survey and Land Use Planning, and Buree Boonsompopphan, PhD, Soil Correlator, Office of Soil Survey and Land Use Planning, Ministry of Agriculture and Cooperatives.

- Mr. Montol Jeamchareon, Acting Director, Center for Agriculture Information, Office of Agricultural Economics.

We made a site visit to Sa Kaeo Province to talk to local officials and villagers in the project area. We met with Mr. Somchai Jittrath, the Governor of Sa Kaeo Province. Also represented at the meeting were the Chief of the Provincial Statistical Unit, the Chief of the Agricultural Unit, and the Chief of the Land

Reform Unit. The province of Sa Kaeo has 679 villages, of which 63 are contaminated with landmines. The main crops are rice, cassava, sugar cane, and eucalyptus. There are two factories for tapioca. Villagers sell to directly to the factory and receive 1.15 baht per kilo for cassava. There is one permanent border crossing and three temporary ones as a result of mine clearance.

At the village of Ban Yong Na Keo we met with 125 villagers who had gathered for civil defense training. From them we learned that the cleared land will be particularly important to their livelihoods because the land will be suitable for cassava production. Currently the uncontaminated, low-lying land in the area is used for rice production. It is unsuitable for cassava because in the rainy season it floods killing the cassava. Unfortunately in the last few years they have experienced drought conditions with occasional downpours. Rice yield has been low. The area cannot be irrigated because it is uphill from all major water sources. The cleared land is higher and will grow cassava, a drought resistant crop. Cassava requires very little in the way of inputs. After harvesting this year's crop (the root is used), the farmer simply sticks the stalks back in the ground and they grow new roots.

Additionally people are accustomed to supplementing their farm income in the off-season by foraging for mushrooms and pakwan (a vegetable) that they sell in the local markets or to middlemen who take it to Bangkok. Many foraging areas are closed to them because of mines. They reported that there are few accidents now among Thais because they know where the mined areas are. However accidents are still occurring regularly to Cambodians coming across the border looking for work or foraging. The people are very impatient with the slow pace of mine clearance. They asked us to recommend that instead of spending all this money on clearance, the government should give them each $200 and they could get a Cambodian to clear their land. Nevertheless they feel clearance programs already improve their lives because the government built them houses in anticipation of clearing the farm plots. Each house is on one rai and allows for some subsistence.

Demining in the Ban Nong Ya Keo area is accomplished through mechanical demining and mine dog teams. The Thai military is tasked to both defend and develop Thailand, so in theory the two could be coordinated. We also toured a World Heritage Site currently being cleared which has Khmer temples, and in Aranyaprathet, a local market on the border. With road clearance and the border opening the market has prospered and truck traffic has increased. With these things occurring motels and restaurants have also opened in the area.

From the site visit we reached the following conclusions:

- Thailand is a data rich country and there is available data on agricultural products and livelihood as well as on demographics,
- There are serious problems with victim data.

- A site visit is important to understanding local conditions and the nuances that might affect which project might be chosen over another.
- Even with a very cooperative agency such as TMAC, it was very hard to get cost data. Institutions are reluctant to release this information.
- Clearly mine clearance has many far-reaching effects but tracing those effects definitively is not possible.

Ethiopia

Background. Ethiopia is among the world's 10 most heavily mined countries. These mines are a legacy of successive conflicts over the last 70 years. There are around 2 million landmines, some dating back to the Italian invasion by Mussolini in 1935. Conflicts with Somalia and Eritrea have resulted in mines on those borders. The government estimates that it will take another 20 years to clear most areas. Regions most affected are Tigray and Afar and the eastern area bordering Somalia. Following the signing of a formal peace agreement in December 2000 and the deployment of the United Nations Mission to Ethiopia and Eritrea (UNMEE), in February 2001 an agreement established a Temporary Security Zone (TSZ), a 25 kilometer-wide demilitarized zone in the former conflict area. Considerable areas of the zone remain contaminated, a major concern with respect to the return of refugees and internally displaced persons.

The government estimates that 70,000 hectares is contaminated by landmines or UXO. A joint mission with the United Nations Development Program (UNDP), UN Mine Action Service (UNMAS), and UN Office for Project Services (UNOPS) traveled to Ethiopia in November 2000 to make recommendations concerning mine action. A technical group was delegated the responsibility of developing recommendations of statutes and a proposed structure for an Ethiopian Mine Action Office (EMAO) was recommended to replace military demining. UNMAS maintains a mine action support program in place to provide technical support to the program and assist in the building of local capacity. (Landmine Monitor 2001).

The country's first humanitarian demining program started in mid-2002. By summer of 2003 it consisted of four companies and employed about 400 deminers. The first of these were trained by RONCO. EMAO reports that it has cleared over 200,000 square meters of contaminated land.

Ethiopia's survey is complicated by the presence of nomads in the contaminated area. During droughts they "follow the rain" and this leads them into mined areas. The LIS protocol is designed to focus on communities – a problem in an area with nomadic populations The community impact scoring system is not compatible with their needs. Mines have created particular problems for the nomads during the current drought. They must go farther and farther to find safe grazing land and their animals suffer from exhaustion and death.

The recently completed LIS found that over the past two years 16,000 people have been involved in landmine blast incidents, of which 1,295 were killed or injured.

Data collection. The MAIC team visited Ethiopia August 17-23. Azeb Gelaye, our coordinator, met with us for an orientation meeting upon arrival and gave us an overview of the mine action organization. We met with Ato Teklewold, head of EMAO. He explained the organization and its goals. He indicated that a primary goal is to resettle internally displaced persons (IDPs). He estimated that 364,000 people have been displaced from Tigray and Afar. He noted that much of the land is for grazing and that 84 animals had been lost in one area. In one year 170 were killed, and 467 were injured. Addditionally in forested areas, people are injured or killed foraging for firewood. In clearing twelve sites, there has been one accident to a deminer who lost a leg. EMAO noted that in 2003, 2, 663, 695 square meters were cleared. As of July 2003, a total of 446 APMs, 42 ATMs, and 2, 176 UXOs were destroyed.

On the basis of meetings with EMAO, we chose two project areas for comparison, Marta and Gerhusenay. In the Marta area, they lost a church and a school, and farm land was closed off to local farmers. In Gerhusenay farmers were denied access to land. Data on the amount of land cleared in these two project areas was obtained from EMAO. EMAO declined to release itemized cost data but did offer an estimate of costs per square meter.

Victim data was obtained from the LIS and also from the Rehabilitation and Development Organization (RaDO), a local NGO working with mine victims. RaDO produces quarterly reports on mine victims and follows victims to learn the outcome of care. RaDO was able to provide us with medical costs as well as figures for victims.

We also met with members of the NPA staff conducting the LIS and were briefed on the extent of the landmine problem in the country. Although currently mine action is limited to a few areas, there is hope that the survey will help to illustrate other areas. There are more than 16000 kebeles (communities) in Ethiopia to survey every one so NPA relied on an initial rapid survey – they visited the districts (weredas) and asked if there is a problem concerning landmines. They identified three operational areas, Tigray and Afar, Somalia region, and all other regions. There are at least 5 languages spoken and surveys are filled in in Amharic and data is stored in IMSMA in Amharic and English.

From the initial survey, they found about 95% were false positives. One added value of the LIS is that it helps to update census and mapping data and thus contributes to other development activities. NPA shared GIS data and victim data.

Meetings with the Ministry of Finance and Economic Development (MOFED) were designed to obtain economic data but were not particularly successful.

However the United Nations Mine Advisory Assistance Team (UNMAAT) was able to help us obtain the information we needed.

The team also met with Darlene Cutshall of the United States Agency for International Development (USAID). She confirmed that the only real interaction between her office and mine action was in the area of mine risk education.

Conclusions drawn from the Ethiopian visit are:

- In less developed countries data collection will be harder to accomplish.
- Government officials seemed suspicious about the use to which information might be put. It isn't clear whether this was a cultural phenomenon or the legacy of a Marxist regime.
- Local NGOs may well prove to be an excellent source of information.
- Local context (in this case the presence of nomadic tribes) is important.

MODEL DEVELOPMENT

As a result of the activities conducted in the first phase of the project, the study team decided to develop both a standard cost-benefit model and an AHP model. On the basis of desk research, the team identified the potential benefits of mine clearance projects. These elements were refined during the site visits to Thailand and Ethiopia. A decision was made to include both direct and indirect benefits in the analysis since benefits that are indirect for one project may be direct for another. Tangible benefits identified are those for which monetary values can be established, intangibles are those, which are difficult or impossible to quantify. Only tangible benefits are included in the standard cost-benefit model. The AHP model includes both tangible and intangible benefits. Where quantitative measures are available they will be used in the pairwise comparisons required by AHP. Tangible benefits are divided into three main categories: risk reduction, livelihood, social and infrastructure.

Tangible Benefits

Lives saved can be considered a tangible benefit by looking at individual contributions to the economy through productivity. [3] A number of different means

[3] There is considerable controversy over whether a value can be assigned to human life and if so, how this is to be accomplished. The model allows for risk reduction to be considered as a tangible benefit but does not require that it be so. We do not recommend using dollar values assigned to lives to compare different countries or to compare lives in a poorer region to those in a wealthier area.

have been developed to estimate the value of human lives (Thompson 1982). None of these is entirely satisfactory and all yield lower values of lives in poorer countries. We have chosen to use national income expressed in terms of purchase power parity divided by the working age population. Risk reduction benefits also include medical costs foregone. These costs would include both emergency care and long-term care for victims.

Direct livelihood benefits include cropping and grazing of agricultural land or the use of reclaimed land for other economic activity. These can be measured by looking at the market value of crops produced per unit of land, value of livestock per unit of land, and value of incomes from other reclaimed land.

Social benefits include such things as the return of displaced persons and access to education and health facilities. The cost of providing for displaced persons provides a monetary value for the former. Where possible the value added per level of education to an individual's income could serve as a measure for the benefit of restoring educational facilities or providing access to facilities formerly blocked. Access to health care may be measured in terms of lives saved. The infant mortality rate is considered by social scientists to be a good indicator of quality of health care available to the population at large. Improvements in the infant mortality rate as a result of reopening health care facilities might be used as an indicator of lives saved. Dollar figures can be estimated based on assumptions concerning lifetime productive activity.

Infrastructure and residential benefits include cleared roads, irrigation canals, power supply sources, and housing. These can be measured by examining time saved by returning roads to use, land production provided by clearing irrigation sources, value of power delivered including contribution to livelihoods, and value of residential property.

Table 3 summarizes these tangible benefits. Each of these benefits potentially can be measured in dollars. However, attention must be given to avoiding double measures when benefits overlap.

Even though many economic benefits are quantifiable, there are economic considerations that may make these measures inadequate for prioritization purposes. For example a project that conveys less benefit in dollar terms may be serving important development goals and may also be expected to provide downstream benefits critical to other projects. Where projects are compared in purely economic terms, land that provides crops for market will prevail over those providing for subsistence. Yet the latter may affect more people and may serve to reduce rural poverty. Under certain circumstances crops for food security may be judged more important than crops for export even though the latter make a greater economic contribution.

Table 3
Potential Tangible Benefits for Cost-Benefit Model

Benefits	Measures
Risk Reduction	
Lives saved	Economic contributions through productivity
Injuries saved	Medical costs saved
	Transport to hospital
	Emergency medical care
	Long term medical care
	Prosthesis
	Therapy
Livelihood	
Land for crops	Value of crops per hectare
Land for grazing	Value of livestock per hectare
Land for non-agricultural economic activity	Income
Forested land	Income from foraging
Social	
Return of displaced persons	Costs saved for care of displaced persons
Schools	Value added of units of education
Health factors (clinics Sanitation and potable water)	Lives saved (productive activity added)
Infrastructure	
Roads	Costs saved in terms of time and travel
Irrigation	Productive value of land irrigated
Power	Value of power in terms of increased production
Residential property	Value of residence

Intangible Benefits

Decisions concerning where to invest in mine action often must take into account goals that are neither purely humanitarian nor economic. Political forces and considerations may be an important part of the decision criteria. Intangible political

benefits include such things as contributions to national and regional stability, building or strengthening relations between donor and receiving states, building government capacity to deliver goods and services, supporting national or international strategic goals, and meeting treaty obligations. These benefits may accrue to donors or to host states. Potential intangible benefits that are expected to accrue from mine action but cannot be easily quantified are not included in the CBA model. Nevertheless, decision makers using CBA should keep these potential benefits in mind. They are presented in Table 4.

Table 4
Intangible Benefits

Humanitarian
Lives saved (where policy makers do not wish to assign dollar values)
Improved nutrition
Improved quality of life
Political
Building government capacity
Strengthening international ties
Improving stability
Meeting treaty obligations
Serving strategic goals
Socio-Economic
Serves national development goals
Serves local development goals
Improves food security
Provides subsistence income to poor
Provides jobs and training for mine clearance
Other:
Improves sustainability of national mine action program

Other intangible benefits include contributions to community goals, contributions to the sustainability of the mine action program, and improvements in the overall quality of life of the local people. Additionally preventing landmine casualties will be considered an intangible benefit where decision makers are reluctant to put a dollar value on human lives.

Costs

Costs (although harder to obtain) are somewhat easier to identify and measure than benefits. These include training, equipment, equipment maintenance, other operating, and personnel costs. Personnel costs include insurance and medical treatment in the event of accidents. Productivity data is used to assess cost per project. Table 5 presents a list of costs.

Table 5
LANDMINE CLEARANCE COSTS

OPERATIONS	CAPITAL
Team Salaries (manual, dog, mechanical)	Equipment
Equipment	Loans
Training	
Medical care/deminer accidents	
Fuel/transportation	
Communications	
Care for dogs	
Administrative overhead	
In-kind contributions	

Cost-Benefit Model

The cost-benefit model developed uses all of the tangible benefits identified above. Each of these is discussed below along with possible sources of data. The method for comparing costs and benefits is the net present value (total discounted benefits minus total discounted costs). This method is the most common in use and is recommended for publicly funded programs (Sylvia, et. al. 1997). The discount rate chosen is 10% but the model allows the user to change this rate. Flexibility is built into the model. The user may choose those fields for which data are available and may make judgments concerning discount rates and other factors. Costs and benefits are based on hectares. Data fields may be left blank where no data is available or the benefit is not applicable.

The productive value of lives and injuries saved is calculated by taking the country's gross domestic product expressed as purchasing power parity and dividing it by the productive population. We have used the proportion of the

population between 15 and 60 for our examples, but the user may choose to use whatever age group seems reasonable for local conditions. The value of productivity can also be adjusted for unemployment. All of the above information is available for most countries from the World Bank's World Development Report or from the United Nation's Human Development Report. These data are also available from statistical offices in country. A value may also be added for income from the informal sector or for the value of leisure time.

If ages of victims are available, the model allows the user to adjust the productivity value for years of productive employment appropriate to the age group. The end result is the discounted value of production based on the number of victims reported by the LIS. We have assumed that most victims will be disabled and have therefore included all victims whether killed or not in our computations. The model allows for expert judgment and any proportion of victims may be used. In the absence of an LIS, victim data usually must be estimated from local sources. Medical costs for long-term care should be available from the mine action centers or from NGOs or government sources.

Agricultural land use benefits are calculated using average crop yield per hectare and the local market price where available. In our examples we were able to obtain this information from local officials, the farmers themselves and from FAO data. Similarly grazing land's productivity can be measured by average number of animals per hectare and market value of livestock. For restoration of irrigation the same calculations are used, i.e., the increase in the productive value of land irrigated. For other economic enterprises, i.e., markets to be established on cleared land or other commercial activities, the average income for those employed is used. If available revenue from taxes are also used.

Benefits from resettling displaced person are computed using estimates of costs for support to these people where applicable. These may be monthly costs or one time payments depending on the country. These figures should be available from government officials and NGOs. Estimates can be made based on the average income needed for subsistence where information on payments is not available.

Where access to schools is restored, the value of additional education to income can be used. In many cases, this figure will not be available. Government statistics are the best source for these data.

Improvements in sanitation or water quality as a direct result of mine clearance can be measured by estimating lives saved and using the productive value of those lives for a dollar amount. Changes in the infant mortality rates may be used as an indicator of lives saved as the infant mortality rate is quite sensitive to the distribution of benefits relating to healthcare.

Infrastructure improvements are generally measured in terms of time saved by the restoration of necessary resources, for example roads. Time saved from traveling

around mined areas for various purposes is computed by using the average hourly wage for the area and multiplying that times the amount of time required by the travelers. The user must estimate the amount of traffic. This type of information can only be obtained locally although it can be estimated by knowledgeable persons. It may also be possible to quantify the benefits to livelihoods caused by restoration of power.

Application to Thailand. Applying the cost-benefit model to Thailand yields very different results for the two projects. For the Chantaburi project, benefits exceed costs. For Sa Kaeo, costs exceed benefits by a substantial amount. The CBA shows that the Chantaburi project is definitely cost effective and should be undertaken.

Reaching a decision on the Sa Kaeo project is more complicated. The economic benefits are limited to livelihood from agricultural land, livelihood from foraging, and the productive value of lives and injuries prevented. However, the project is large and will take approximately 15 more years to complete. Clearance is accomplished primarily with dog teams. The CBA indicates that in strict economic productivity terms, the project is not cost effective. However, a number of intangibles should be taken into account. First, the Thai government is anxious to resettle the border area as a security measure. Villages established are self-defense centers. Second, Thailand's primary development goal recognizes that it is an agricultural country and aims at making all farmers self-sufficient. Because of drought conditions and the absence of irrigation options, Ban Nong Sa Keo farmers have not been as successful as they would like in terms of rice production. The mined land is suitable for cassava which is drought resistant. Additionally the villagers note that as an indirect consequence of the clearance project, their lives have already improved substantially. They have been provided with housing and small garden plots, and children have returned the village and the nearest school is flourishing. Finally, the project area received a high impact score on the LIS. Although Thai casualties have been reduced, Cambodians continue to be injured. The Thai application suggests that combining AHP with cost-benefit analysis may be useful. This application is discussed in the next section.

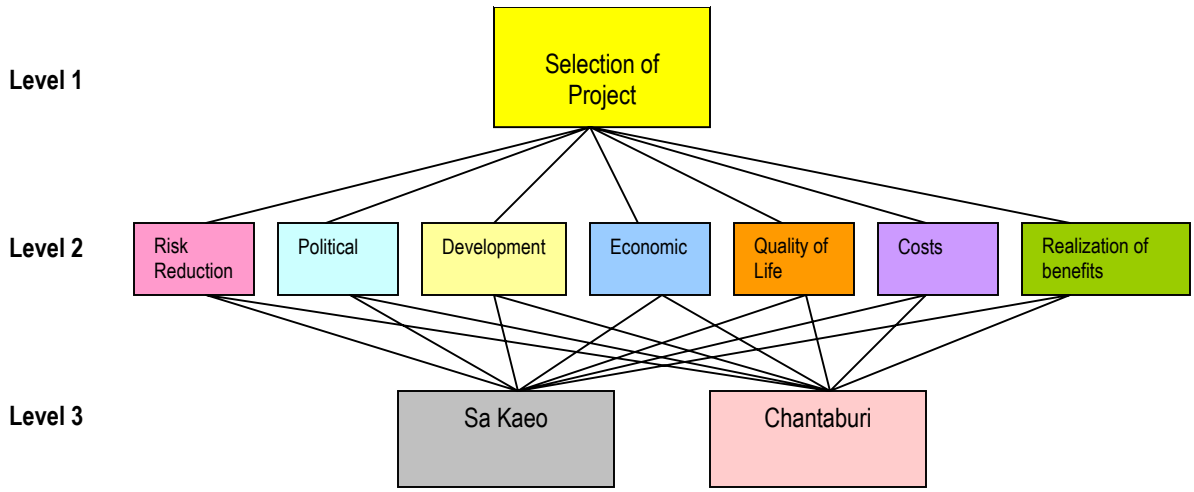
Application to Ethiopia. In both of the project areas chosen for Ethiopia returning internally displaced persons (IDPs) is the primary benefit of clearance. In the Marta project area clearance provides for access to a road previously closed to Zala Ambessa. For the Marta project, there are present value dollar benefits exceeding costs by more than $93 M dollars. This is due in part to the large number of IDPs served by this project, and the time saved by traveling the cleared road to Zala Ambessa. The Gerhusenay project also shows net benefits. In the Ethiopian case prioritization on socio-economic criteria alone would suggest that the Marta project is preferred to Gerhusenay. It should be noted that Gerhusenay presents a higher risk with eighteen recent victims to Marta's 10, but the larger number of IDPs and the benefits of road clearance make Marta the preferred project using CBA. The Marta project presents a good example of collaboration between local and national

authorities as the site for beginning the project was moved when local officials expressed a need to reopen the road to Zala Ambessa.

Detailed directions for using the CBA model and detailed explanations of the Thai and Ethiopian cases can be found in the manual included with this report. Spreadsheets are provided for entering data.

Analytic Hierarchy Model

Figure 2



The analytic hierarchy model (AHP) allows for the inclusion of intangibles and also allows for collaborative decision making processes. We have established the goal (first level) as choosing the mine action project that provides the greatest humanitarian and socio-economic benefit. Seven criteria are used to determine whether the goal is met. These are risk reduction, political concerns, development, economic benefit, quality of life, costs, and realization of benefits. These were chosen with the Thai projects in mind. The hierarchy is displayed in Figure 2.

These criteria can be changed to suit different scenarios. Additionally each of these criteria can accommodate shifts in meaning among different levels of decision makers. For example donors may consider building relationships with the host state to be the most important of the political factors and they may influence their weighting of that criterion. At the same time, decision makers in the host state may put more weight on stability.At the third level of the hierarchy decision makers are asked to evaluate the two projects relative to one another against each of the level 2 criteria. In making these judgments, decision makers may use any actual data they possess as well as expert opinion. The level 2 criteria are then paired and evaluated

in terms of their contribution to meeting the overall goal – to choose the mine action program that maximizes benefits relative to costs. A template is provided for entering the pair wise comparisons that automatically computes the priority weights.

Although the study team has identified criteria based on the research completed for this project, part of the value of the process is having decision makers develop those criteria they believe are important to the goal. Cost must be one of the criteria. Thus substitutions can be made for any of these criteria and more or fewer criteria can be used. Additionally more than two projects may be evaluated. 6 presents a number of criteria that should be considered and the specific questions for evaluators to address. The scoring system is given with the first criterion. It is the same for all criteria. The projects are paired and scored based on the answers to the questions. For example if project A is greatly preferable to project B in terms of supporting a national strategic plan, it would receive a score of 7 to 9 based on the evaluator's judgment. Project B would receive the reciprocal.

Once the projects are compared with each other relative to the criteria selected, each criterion must be compared to each of the others to assess its relative contribution to the goal. For example, the evaluators should judge which is more important in choosing the best project; promoting political stability or preventing injury. Table 6 presents the questions asked for this process. The question to be answered in each case is: How do these two activities compare in their contribution to the objective of choosing the most effective mine clearance project? The same scoring technique is used. See Table 6.

As the pair wise comparisons are made, the scores are entered into a matrix. In comparing projects against criteria, a separate matrix is devised for each criterion. A sample is shown in Table 7a-b. In Table 7a the Sa Kaeo project is very strongly preferred to Chantaburi for reducing risk. In Table 7b, Chantaburi is preferred to Sa Keao for After scores are assigned they are normalized by dividing each score by the column total. Scores are then averaged across columns.

For comparing the criteria a single matrix is needed. A detailed description of the AHP model can be found in the manual included with this report.

Table 8 illustrates the ranking of criteria using the pair wise comparison method, For example, risk reduction is preferred over all other criteria as a condition for choosing the best project. These scores are normalized and weights computed. Table 9 shows the outcome of the AHP. The weighted average score for each project is produced by multiplying the project score in each row by the row total. The Sa Kaeo project is mildly preferred using the AHP process. When Using AHP and considering intangibles, the two projects are much closer in terms of preferences than from using the quantitative analysis alone.

It should be noted that if one project is preferred for all criteria then you do not have a decision problem. AHP becomes useful when one project is better for some criteria and the other project is better for the rest of the criteria.

The consistency ratio (see Table 7) examines how consistent the evaluator is in stating preferences. If the evaluator is absolutely consistent then the consistency scores will equal the number of alternatives and the consistency ratio will be 0. This is rare where there are several alternatives. It is generally accepted that if the consistency ration is $\leq .10$ the process is considered to have produced reasonably consistent results.

(Conclusions follow after tables.)

Table 6. Approaches to Assessing Projects Against Criteria and Criteria Against Each Other

Supports National Goals	To what degree does this project support a national strategic plan? Equally important in meeting this option (score=1) Moderately more important (score=3) Strongly more important (score =5) Very strongly more important (score = 7) Extremely more important (score = 9) This criterion requires consultation with development planners.
Supports Community Goals	To what degree does this project support important community goals? If LIS is available then LIS scores for projects can be used to make this comparison.
Meets Treaty Obligations	Does this project fulfill treaty obligations?
Promotes Self-Sustainability	How likely is it that this project will improve the self-sustainability of the mine action program?
Promotes Political Stability	In your opinion, will this project help to diminish political tensions and instability? These may be defined differently by donors and host state planners.
Promotes Economic Stability	In your opinion, will this project help to promote economic stability by such things as providing tangible benefits, encouraging competitive markets, providing training transferable to other economic sectors, etc.? When available actual tangible benefit figures should be used (see CBA model)

Table 6 (continued)

Improves the Quality of Life for Members of this Community	How important is this project to improving the quality of life for the residents of this community, for example by improving access to infrastructure, reducing time spent getting water, providing housing, etc,? Requires consultation with community.
Capacity Building	To what extent will this project contribute to improving the ability of the host government to deliver necessary goods and services including providing for public safety?
Costs	To what extent does this project provide benefits at lower cost? When available actual costs should be used.
Likelihood Cleared Land Will Be Used	What is the likelihood that the land once cleared will be used for the purpose intended? This criterion requires consultation with local community and with development planners.
To Compare Criteria	
For each pair of criteria above:	How do these two activities contribute to the objective of choosing the most effective mine clearance project? Equally important in meeting this goal (score=1) Moderately more important (score=3) Strongly more important (score =5) Very strongly more important (score = 7) Extremely more important (score = 9)

Table 7a.
Risk Reduction Pair wise Comparisons

	Sa Kaeo	Chantaburi
Sa Kaeo	1.000	7.000
Chantaburi	0.143	1.000
Sum	1.143	8.000

Normalized Comparisons

	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.875	0.875	0.875
Chantaburi	0.125	0.125	0.125

Table 7b.
Realization of Benefits Pairwise Comparisons

	Sa Keao	Chantaburi
Sa Keao	1.000	0.143
Chantaburi	7.000	1.000
Sum	8.000	1.143

Normalized Comparisons

	Sa Keao	Chantaburi	Scores
Sa Keao	0.125	0.125	0.125
Chantaburi	0.875	0.875	0.875

Table 9
AHP Results

Criterion	Sa Keao	Chantaburi	Criterion Weights
Risk reduction	0.875	0.125	0.278
Pol Stability	0.500	0.500	0.131
Development Goals	0.833	0.167	0.097
Economic	0.167	0.833	0.090
Quality of Life	0.900	0.100	0.101
Costs	0.125	0.875	0.160
Realization	0.125	0.875	0.150
Weighted Avg Score	0.535	0.473	1.008

Table 8

Criteria Pairwise Comparisons

	Risk reduction	PolStability	DevGoals	Economic	Quality of Life	Costs	Realization
Risk reduction	1.000	3.000	2.000	3.000	3.000	2.000	2.000
Pol Stability	0.333	1.000	1.000	1.000	2.000	0.500	2.000
Dev Goals	0.500	1.000	1.000	1.000	1.000	0.500	0.500
Economic	0.333	1.000	1.000	1.000	1.000	1.000	0.500
Quality of Life	0.333	0.500	1.000	1.000	1.000	0.500	0.500
Costs	0.500	2.000	2.000	1.000	2.000	1.000	1.000
Realization	0.500	0.500	2.000	2.000	2.000	1.000	1.000
Sum	3.500	9.000	10.000	10.000	12.000	6.500	7.500

Normalized Comparisons

	Risk reduction	PolStability	DevGoals	Economic	Quality of Life	Costs	Realization	Criterion Weight	Consistency Measure
Risk reduction	0.286	0.333	0.200	0.300	0.250	0.308	0.267	0.278	7.424
Pol Stability	0.095	0.111	0.100	0.100	0.167	0.077	0.267	0.131	7.596
Dev Goals	0.143	0.111	0.100	0.100	0.083	0.077	0.067	0.097	7.341
Economic	0.095	0.111	0.100	0.100	0.083	0.077	0.067	0.090	7.893
Quality of Life	0.095	0.111	0.100	0.100	0.083	0.154	0.067	0.101	7.370
Costs	0.143	0.222	0.200	0.100	0.167	0.154	0.133	0.160	7.500
Realization	0.143	0.056	0.200	0.200	0.167	0.154	0.133	0.150	7.270

Consistency Ratio	0.061

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CONCLUSION

CBA can demonstrate that mine clearance, in spite of high costs, does return net tangible benefits. As a means of demonstrating the utility of mine clearance to funding sources, it can be very useful. CBA can also point out those cases where clearance is unlikely to yield net tangible benefits and may alert decision makers that these projects need to be examined carefully. Alternatives to clearance (land reduction) may be more appropriate for some of these areas.

CBA can provide important information for prioritizing projects where reliable data can be attained or estimated and where trade-offs among intangible costs and benefits are relatively clear. CBA can provide much needed transparency in decision making. However, CBA may not be appropriate as the *sole* approach for prioritizing mine clearance projects where:

1. intangibles are as important to decision makers as tangible outputs. Questions concerning intangibles should be considered as a necessary step in using CBA. What contribution will the project make to national or regional security? How might the project funding help to build important international relationships? Is it more important to provide self-sufficiency for the rural population than for the relatively well off farmer to produce crops for market?

2. outcomes are particularly unclear. How likely is it that the expected benefits will occur? Do farmers possess the necessary inputs to use the land? Is the area safe enough that farmers will return? What potential unintended consequences may threaten successful outcomes? No one can predict the future but a collaborative decision making process in which knowledgeable people at all levels have input is more likely to uncover potential roadblocks to success where outcomes are uncertain.

3. projects among states or localities at very different levels of economic development are to be considered. Many of the costs of clearance reflect prices in wealthy societies but the benefits will be priced in terms of local standards of living. Projects in wealthier countries will return higher dollar values as land and housing cost more, agriculture will have a higher yield and local market prices will be higher, etc.

4. there are serious problems with obtaining reliable data.

5. context cannot be adequately addressed by the decision makers. Context is extremely important for understanding the true nature of benefits. What are development goals for this particular region? Are there special considerations that, if known, might push decisions in a particular direction?

Recommendations

For these reasons, the study team recommends that consideration be given to using multi-criteria analysis as a means of including knowledgeable judgments concerning benefits. We believe that the use of a tool such as the analytic hierarchy process will fulfill the recommendations listed below. Specific recommendations:

1. Assign socio-economic concerns a larger role in prioritization once the immediate post-conflict period is over and risk reduction is no longer as crucial.

2. Recognize mine action as a development activity. Mine action funds should be mainstreamed.

3. Adopt a decision making procedure that is transparent and collaborative.

4. Include development planners and local constituencies early in the decision making process early.

5. Consider alternatives to clearance where benefits are unlikely to exceed costs and where intangibles do not support clearance in spite of costs.

6. Consider enlarging the Freeways decision tool to include socio-economic considerations.

7. Imbed flexibility in any decision making tool adopted.

The accompanying manual contains templates for cost-benefit analysis and AHP applied to prioritizing mine clearance operations. These are demonstrated using the data collected from Thailand and Ethiopia.

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