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Decisions Tools Manual

CISR
Center for International Stabilization and Recovery

Decision Tools Manual
Humanitarian Mine Action Projects

In Support of
The US Department of State Strategic Plan
And
National Policy Guidance

Submitted to:

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I. Introduction

As early as 1998, the United Nations Policy on Mine Action and Effective Coordination documented the importance of prioritization of humanitarian mine action projects in the section titled, "The Requirement for Prioritization and Accountability." (van der Merwe 2003) It stated

> "All programmes should have well-established mechanisms to set priorities for mine action activities on the basis of need and the most effective use of available resources. While it must be remembered that no two situations are alike, priorities for mine clearance will often include, inter alia, the following: provision of emergency assistance; settled land with high civilian casualty rates; land required for the resettlement of refugees/internally displaced persons (IDPs); land required for agriculture; community development; access to and free operation of health services; reconstruction; and infrastructure development. Programmes should also incorporate clearly defined accountability mechanisms to ensure that priority needs are met and that there is cost-effective use of available resources."

The mine action community sensibility to the issue of allocation of limited resources for humanitarian mine action projects has led economists and other researchers to pursue new models to prioritize the areas for clearance. Admittedly, the Landmine Impact Survey ranks community needs by the severity of the socio-economic impact caused by landmines and UXO, but it continues to emphasize casualties.

As J.J. van der Merwe stated, "what is needed is to go one step further to prioritize these identified areas into a list from which a programme is able to select tasks and compile a work program." (2003) Van der Merwe does suggest an assessment of both the socio-economic blockages and the technical aspects of the minefield as well as the minimum clearance activity required. As for the latter, the Survey Action Center is currently doing work that will aid in identifying the point at which clearance produces diminishing returns.

With regard to the assessment of socio-economic impacts of mine clearance, several studies of note have taken the process one step further with the quantification of benefits accrued by mine clearance projects. They include "A Study of Socio-Economic Approaches to Mine Action" (GICHD 2001) that explores the use of cost-benefit analysis to prioritize projects. Other researchers have called for continuous information collection to aid in evaluating mine action tasks in terms of socio-economic benefits (Byrd and Gildestad 2001). These studies have noted the difficulty in assessing the socio-economic impact of landmines with the limited availability of data and the difficulty in quantifying intangible benefits. They have called for ways to prioritize among potential projects that include

the use of cost-benefit analysis and the recognition of the impact on the socio-economic benefits and costs. So far, this remains a challenging task.

In 2003, the United States Department of State, Bureau of Political-Military Affairs/Weapons Removal and Abatement, (PM/WRA) tasked the James Madison University Mine Action Information Center (MAIC) with producing 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. Lessons learned from UN guidance, earlier studies, experts in the mine action community, and field studies influenced the development of the decision tool for prioritization of humanitarian mine action projects.

The MAIC team reviewed different methods of conducting cost-benefit analysis, including their usefulness and disadvantages, prior to field studies in Thailand and Ethiopia. These countries provided insight and first hand validation of the selection of parameters for a cost-benefit analysis model that would prioritize humanitarian mine action projects.

Due to the difficulty in obtaining quantitative data, particularly for socio-economic factors, several multi-criteria approaches were also examined and the analytic hierarchy process was chosen for consideration. The report, "Decision Tools for Selection of Humanitarian Mine Action Projects," (Knickrehm and Stewart 2004) was written in tandem with this manual and describes the background material and field study notes for the development of these models.

II. Scope of the Decision Tools Manual

This manual is a hands-on approach to using both the Cost-Benefit Analysis Model, and the Analytic Hierarchy Process Model. The CBA Model allows the user to quantify the benefits accrued by a country for lives saved, increased agricultural output, costs foregone for the resettlement of internally displaced persons (IDPs), and other benefits gained ranging from grazing to community development and infrastructure.
More importantly, the manual includes EXCEL spreadsheets that allow the user to enter local data, and automatically calculate the benefits and costs. Finally, the manual explains and the spreadsheet calculates the net benefits (or costs) of the program.

The AHP Model is an intriguing alternative approach to decision-making that has been used successfully by the business community for some time. This model allows for subjective assessment and expert input. Here, one has the opportunity to apply this technique to the prioritization of mine action projects. Again, the manual illustrates how the model works. It also provides spreadsheet support that can be easily used by an organization for prioritization of its projects.

In order to develop a realistic and user-friendly manual, the team has incorporated real time data from two field studies. By using real data, it is anticipated that the user will employ the models as presented, OR, modify them according to determination of alternate measures and data availability.

Field Examples:

- **Thailand**

The MAIC team visited Thailand May 31- June 8, 2003. In Thailand the team received a briefing from Dave McCracken, Technical Advisor to the Thai Mine Action Center (TMAC) that 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). The purpose of the project is to increase self-sufficiency among village farmers in accordance with the National Plan. After clearance each family will receive 14 rai.

We made a site visit to Sa Kaeo Province to talk to local officials and villagers in the project area. 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 an average of 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 would be particularly important to their livelihoods because the land will be suitable for 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.

In Chantaburi province, the Humanitarian Mine Action Unit (HMAU#2) has cleared a plot of 32 rai for a market. A location close to the Cambodian border makes this site a security issue. Currently, an estimated 800-2000 Thai and Cambodian customers visit the market daily. There are approximately 106 small vendors/small shops in the market. The goods range from clothing, fertilizer, sugar, drinking water, cooking oil, and rice, to common household items. These tenants pay a monthly fee of about 10.00 – 15.00 USD for a shop of 4 m by 5 m.

A local official manages the market under the supervision of the Department of Agriculture. It is anticipated that the entire market area (32 rai) will eventually be leased for additional shops, parking, and other uses.

- **Ethiopia**

Ethiopia is among world's 10 most heavily mined countries. These mines are a legacy of successive conflicts over the last 70 years. The recently completed Landmine Impact Survey (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.

The MAIC team visited Ethiopia August 17-23, 2003. Azeb Gelaye gave us an overview of the mine action organization prior to our interview with Ato Teklewold, head of the Ethiopian Mine Action Organization (EMAO). He indicated that a primary goal of EMAO 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.

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 Norwegian People's Aid (NPA) staff conducting the LIS and were briefed on the extent of the landmine problem in the country. There are more than 16000 kebeles (communities) in Ethiopia to survey, 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 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 LIS has been that it helps to update census and mapping data. 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 Action 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.

With a better understanding of the benefits and costs associated with landmine clearance, the MAIC team returned home and began to test the models. The team had the opportunity to apply both the CBA and the AHP Models to real world data in real time. This had the advantage of discovering the strengths of each model, and its weaknesses as well as their role in decision-making environments. The following sections explain the fundamentals of the models and illustrate how to apply them.

III. Cost-Benefit Analysis Model

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 (benefits minus costs). 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 discount rate chosen is 10% because resources are often scarce in developing countries. Also, this is the rate most commonly used in similar studies during this period. Do note that the model allows the user to change this rate. Sensitivity analysis allows the user to alter both the discount rate and the number of years for the revenue stream or period of incurring costs. The CBA model included here allows the user to conduct sensitivity analysis by varying the discount rate and time period

The most common way to compare the costs and benefits is by computing the net present value (NPV), that is, 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). A positive NPV is said to return benefits. In the comparison of two projects, the one with the greater NPV is said to be preferable.

Cost-benefit analysis gives decision makers a tool for decision-making that makes the process more transparent. The CBA Model developed for this study presents the most likely tangible benefits and costs for a mine action project, that is those benefits and costs for which a dollar value can be assigned. The next section presents each of these along with possible sources of data.

There is a caveat that although the CBA Model is effective when dealing with quantifiable factors, there are limitations with the technique. The user must recognize that a CBA is unable to effectively consider intangible costs and benefits, or integrate the judgments of experts for the political process (Sylvia 1997).

In order to begin, you need to know:

- Benefits for your projects
- Costs of your projects
- An appropriate discount rate
- The number of years over which you want to discount your benefits and costs

Let's begin…

A. Benefits

Based on literature review, research, and the field studies, the team has identified the most likely benefits associated with humanitarian mine action projects. Lives and injuries saved is the most widely accepted direct benefit of mine clearance. All other benefits proposed can be either a direct result of the project or an indirect impact depending on the mine action activity. Direct or indirect classification does not affect the model process.

It is important to understand that a CBA Model can only address direct or indirect benefits and costs that are tangible, that is: those to which a dollar value can be assigned. Table 1 suggests tangible benefits for humanitarian mine action projects. As a supplement, ANNEX A gives a more detailed description of the benefits, appropriate quantitative measures, the data necessary to calculate the measures, and reliable sources in one location.

Table 1: Tangible Benefits for Cost-Benefit Analysis Model	
Benefits	Measures
Direct	
Risk Reduction Lives saved Injuries saved	 Economic contributions through productivity Medical costs saved: Transport to hospital Emergency medical care Long term medical care Prosthesis Therapy
Direct or Indirect	
Livelihood Land for crops Land for grazing Land for non-agricultural economic activity Forested land	 Value of crop yield Value of livestock lost Revenue, Income Income from foraging
Direct or Indirect	
Social Return of internally displaced persons (IDPs) Schools Health factors (clinics, potable water and sanitation facilities)	 Subsistence costs foregone for care of IDPs Value added per year of education Infant mortality rate
Direct or Indirect	
Infrastructure Roads Irrigation Power Residential property	 Costs saved in terms of time and travel Productive value of land irrigated Value in terms of increased production Property values

It is noteworthy that decision-makers also consider intangible factors such as political stability, or national goals, when making a final selection. Table 2 presents the most likely intangible benefits that might accrue to a mine clearance project. Since a multi-criteria model can better assess intangible considerations, the manual addresses those benefits using the Analytic Hierarchy Process (AHP) Model (see section IV).

Table 2: 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

The next section explains methods that are useful in developing the tangible benefits for the CBA prioritization process. The manual illustrates them using the following format:

- Description and explanation of the benefit
- Assumptions for Field Study
- Field example: description and spreadsheet application
- Measures used and calculation process

1. Risk Reduction

Lives and injuries saved, or risk reduction, is an expected benefit from mine clearance projects. There are several ways to attribute value to a life saved, none of which can ever quantify the true value of a human life. However, for purposes of illustrating economic benefits, 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.

The CBA Model uses the proportion of the population between 15 and 60 for examples, but the user may choose to use whatever age group seems reasonable for local conditions. 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. A value may also be added for income from the informal sector or for the value of leisure time. Additionally, the value of productivity can be adjusted for unemployment.

The end result is the discounted value of production based on the number of victims reported by the Landmine Impact Study (LIS). The model assumes that most victims will be disabled and has therefore included all victims whether killed or not in the computations. In the absence of an LIS, local sources often provide victim data. Medical costs for long-term care should be available from the mine action centers, from NGOs, or government sources.

All of the above information is available for most countries in 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.

Assumptions for Field Study Analysis: Sa Kaeo, Thailand

- Most victims will be disabled, therefore the model includes all victims whether killed or not in the computations.
- Age cohort data can be used to adjust the productivity value for years of productive employment appropriate to the age group.
- It is uncommon for people in less developed societies (especially rural people) to supplement their income through informal means. Where income from this sector can be determined it can be added. The $100 is an estimate of the income generated from foraging for mushrooms and wild vegetables based on interviews with HMAU#1 and villagers.
- In their study of Afghanistan, Byrd and Gildestad add a value for leisure time. In their leisure they build families and contribute to community life (Byrd and Gildestad 2001). The livelihood benefits for Sa Kaeo do not include this value for leisure activity because it is not the usual practice, however the spreadsheet allows for such a value to be added.
- Productivity can be adjusted for unemployment.
- Risk Reduction benefits for Chantaburi, Thailand, and Marta and Gerhusenay, Ethiopia are located in Annex 2.

Figure 1: Risk Reduction -- Lives Saved, Injuries Saved, Medical Costs Foregone

Country/Project	PPP (thousands)	Productive population	Lost Productivity wages	Informal Sector/Leisure	Lost Productivity total	Cohort	Yrs of productive labor
Thailand/SaKeo	391,700,000	33,342,400	11,748	100	11,848	<18	40
						18-40	30
						>40	10

Discount Rate	Discounted Value Production	Absolute Value	Employment Rate	Unemployment Discount	No. of Deaths/ Injuries	Share Prod. Value	Total Productive Value
0.1	($115,860.28)	$115,860.28	97.4%	$112,847.91	0	$0.00	$979,059.12
	($111,688.24)	$111,688.24		$108,784.35	9	$979,059.12	
	($72,799.63)	$72,799.63		$70,906.84	0	$0.00	
Injuries	**Primary assistance**	**Wheel chair**	**Prostheses**	**Support**			
	$107.41	$105.52	$126.77	$694.44			
Discounted	-$816.97	-$802.59	-$964.22	-$5,281.97			
Absolute value	$816.97	$802.59	$964.22	$5,281.97			
Victims	6	0	0	6			
Total	$4,901.81	$0.00	$0.00	$31,691.80			
Grand Total (Medical)	$36,593.61						
Total Benefits	$1,015,652.73						

Figure 1a: Risk Reduction- Lives Saved, Injuries Saved, Medical Costs Foregone

FACTORS	MEASURE	DATA COLLECTION and/or CALCULATION
1. Gross Domestic Product/ Purchasing Power Parity (GDP/PPP)	USD	World Bank World Development Report or United Nations Human Development Report
2. Productive Population	18 – 50	National Statistical Office, Office of the Prime Minister, Thailand
3. Lost Productivity Wages	USD	Purchasing Power Parity (PPP)/ Productive Population * 1000
4. Informal/Leisure Sector	USD	Informal: $100 estimate based on interviews with HMAU #1 and local interviews. No estimate of leisure time (see assumptions).
5. Lost Productivity Total	USD	Lost productivity wages + Informal/leisure
6. Cohort	<18 18 – 40 >40	Use age cohort data if available for more accurate estimate. Landmine Impact Survey (LIS)
7. Proportion of Losses	Percentage	Victim data as available, percentage of losses by cohort. (LIS)
8. Years of Productive Labor	Number of years	Byrd & Gildestad 2001
9. Discount Rate	Rate	Reflects interest rate. 10 percent is rate most often used in World Bank studies. This factor is subject to sensitivity analysis, i.e. variable rates.

10. Discounted Value of Production	USD	Present Value (PV) computation Discount rate (d) = .1 Lost productivity total = future value (FV) Compute for each age cohort <18 = 10 years 18 – 40 = 40 years > 40 = 30 years See EXCEL Spreadsheet.
11. Employment Rate	Rate	World Bank, World Development Report or United Nations, Human Development Report. In-country Ministry of Economic Development or Commerce.
12. Unemployment Discount	USD	Absolute value of PV * Employment rate
13. Loss Relative Share	USD	Unemployment discount * Proportion of losses (for each age cohort)
14. Total Productivity Saved	USD	Sum of age cohort calculations for loss relative share.

2. Livelihood

Land for Crop Production

Agricultural land use benefits are calculated using average crop yield per km^2 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 the UN Food and Agriculture Organization (FAO) data. Similarly, the average number of animals lost and market value of livestock can measure grazing land's productivity.

For other economic enterprises, i.e., markets to be established on cleared land or other commercial activities, the average income for those employed in retail enterprises is used. An increase in market revenues could be more accurate. One can often obtain this data in country. Forested land can provide a subsistence income for farmers when there is no cropland or it is unproductive due to drought.

Assumptions for Field Study Analysis: Sa Kaeo, Thailand

- For this project, every household (210) will receive about 14 rai, yielding a project size of 2940 rai. The conversion factor for 14 rai is 22,400 square meters. The village project is 4.70 Km2, that is 210 plots * 22,400/1,000,000.
- It is estimated that HMAU#1 will clear 12-14 plots of land/year. Mine clearance of this agricultural area will take approximately 15 years.
- The average yield for cassava is 42 tons per 14 rai. Upon clearance of 210 plots, it is estimated that farmers will harvest 8820 tons.
- The market price for cassava was $23.28/Ton in 2003.
- The estimate for input factor costs is 220 baht/ton or 1,940,400 baht for 8820 tons harvested. At the exchange rate of 1 Thai Baht = 0.02554 USD, on February 26, 2004, input factors such as labor, fertilizer, and seed cost 49,480 USD. It is projected that input factors will increase by 1 percent each year due to the low inflation rate.
- FINDING: At full production of 4.704 km2, there is net production revenue of $2,013,518.59. Streaming that revenue out over 20 years at a 10 percent discount rate yields a present value of $632,367.35.

Figure 2: Livelihood – Land Clearance for Crop Production

Country:	Year:	Land Type:	Amount of Land:	Crop(s):	Harvest Yield:	Crop Intensity:	Market Price:	Production Revenue:	Input Factors:	Net Production Revenue:	NET PRESENT VALUE:
Thailand	2003-23	(FREEWAY Category)	(Km2)	(Km2)	(Tons/Km2 = 1,875)	(crops/yr)	(USD/ton = $23.28)	(USD/Km2 =$43,650)	(USD/Km2 = $5.61/ton)	(USD Benefits)	(USD)
Sa Kaeo		Grassland	4.704	Cassava	1,875	1	23.28	$2,652,785.1	$639,266.51	$2,013,518.59	$632,367.35
								20-yr	20-yr	20-yr	10%, 20-yr
					8,820			$205,329.60	$49,480.20	$155,849.40	
					year 15			yr 15-complete		year 15	
	1		0.310		581.25			$13,531.50	$3,260.81	$10,271	
	2		0.620		1,162.50			$27,063.00	$6,521.63	$20,541	
	3		0.930		1,743.75			$40,594.50	$9,782.44	$30,812	
	4		1.240		2,325.00			$54,126.00	$13,043.25	$41,083	
	5		1.550		2,906.25			$67,657.50	$16,304.06	$51,353	
	6		1.860		3,487.50			$81,189.00	$19,564.88	$61,624	
	7		2.170		4,068.75			$94,720.50	$22,825.69	$71,895	
	8		2.480		4,650.00			$108,252.00	$26,086.50	$82,166	
	9		2.790		5,231.25			$121,783.50	$29,347.31	$92,436	
	10		3.100		5,812.50			$135,315.00	$32,608.13	$102,707	
	11		3.410		6,393.75			$148,846.50	$35,868.94	$112,978	
	12		3.720		6,975.00			$162,378.00	$39,129.75	$123,248	
	13		4.030		7,556.25			$175,909.50	$42,390.56	$133,519	
	14		4.340		8,137.50			$189,441.00	$45,651.38	$143,790	
	15		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
	16		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
	17		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
	18		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
	19		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
	20		4.704		8,820.00			$205,329.60	$49,480.20	$155,849	
								$2,652,785.10	$639,266.51	$2,013,519	

Figure 2a: Livelihood – Land Clearance for Crop Production

Data Points	Measure	Data collection or calculation
1. Amount of Land	Km2	Determine amount of land cleared per year. If area of land is in another measure, for example Rai, in Thailand, one must convert the Rai to Km2.
2. Crop	Km2	Identify the amount of land to be planted in one or more crops. In the example above, all land is planted in cassava. However, if half the land were planted in rice, and half in cassava, one must compute the yield for each crop.
3. Harvest Yield	Tons/Km2	What is the average yield per Km2? The Ministry of Agriculture, or the district, or the local community can usually provide this data. If yield is not in tons, convert to tons before continuing. To compute: Harvest Yield = Tons/Km2 X Amount of Land (Km2)
4. Crop Intensity	Crops/Year	How many plantings per year for each crop planted? While one is often the norm, look for additional yield if there are two or more crops/year. Multiply the number of crops by the yield per Km2. To compute, IF more than one crop/year: Harvest Yield for Multiple Crops = Harvest Yield X Number of crops/year
5. Market Price	USD/Ton	Again, the Ministry of Agriculture is a good source, or the local village/community. One can use either the Market Price estimate, or the Farmgate price (paid to farmer) estimate. Convert the price from the national currency to USD. (See CURRENCYCONVERTER.COM)
6. Production Revenue	USD/Km2	To compute this factor: Production Revenue = Harvest Yield(one or multiple crops) X Price
7. Input Factors	USD/Km2	Input factors include the cost of seeds, fertilizer, labor, etc. Convert the total from the national currency to USD. (See CURRENCYCONVERTER.COM) To compute: Input factors = SUM of cost of seeds, fertilizer, labor, etc. **Source: Chief of District Agricultural Office, District of Kok Soong

8. Net Revenue	USD	Note that the benefits may differ from year one through year 20. They are dependent on how much land has been cleared, market price, and agricultural expenses. To compute: Net Production Revenue = Production Revenue - Input Factors
9. Present Value	USD	Convert benefits to present value dollars. Present Value (PV) computation Discount rate (d) = .1, Stream of benefits suggested for 20 years as farms could produce indefinitely. Net Production Revenue= future value (FV) See EXCEL Spreadsheet.

Land for Non-agricultural Development

There are times when landmines are cleared from an area for other than agricultural uses. In this example, the land was developed as a village market. The template below offers an example of how to estimate the benefits from this use. Flexibility and logic rein here as the quantification of benefits depends on the specific use, and the type of data that are available. This template works for this study. It will require modification for other uses, e.g. industrial development.

Assumptions for Field Study Analysis: Chantaburi, Thailand

- Since the Sub-Taree Market in Chantaburi is 3 Km from the Thai-Cambodian border, the analysis projects a 10 percent growth factor for the first five years, before it is fully developed and stabilizes.
- The analysis uses the average value of products sold/household for the whole kingdom, as regional data were unavailable in English. Where possible, more precise estimates are always preferred.
- A discount rate of 10 percent, and a stream of benefits for 20 years have been assumed.
- FINDING: A benefit of $1,880,708.91.

Figure 3: Land Development -- Calculations of Benefits

Country	Year	Land Type	Amount of Land	Development: Commercial Use	Number of Market Vendors	Average value of products sold/household	Less Monthly Expenses	Total Revenue	BENEFITS Present Value
Thailand	2003 - 23	(FREEWAY Category)	(Km2)			(USD)	(USD)	(USD)	(USD)
						$1,631	$180		
			32 rai			(= 63,874 baht)			
Chantaburi		Grassland	0.512	Market	106	$5,268,130	$581,400	$4,686,730.00	$1,880,708.91
						20-yr	20-yr	20-yr	10%, 20 –yr
						$172,886	$19,080	$153,806.00	
						year 1	year 1	year 1	
	1		0.512		106	$172,886	$19,080	$153,806.00	
	2		0.512	10%	117	$190,827	$21,060	$169,767.00	
	3		0.512		129	$210,399	$23,220	$187,179.00	
	4		0.512		142	$231,602	$25,560	$206,042.00	
	5		0.512		156	$254,436	$28,080	$226,356.00	
	6		0.512		172	$280,532	$30,960	$249,572.00	
	7		0.512		172	$280,532	$30,960	$249,572.00	
	8		0.512		172	$280,532	$30,960	$249,572.00	
	9		0.512		172	$280,532	$30,960	$249,572.00	
	10		0.512		172	$280,532	$30,960	$249,572.00	
	11		0.512		172	$280,532	$30,960	$249,572.00	
	12		0.512		172	$280,532	$30,960	$249,572.00	
	13		0.512		172	$280,532	$30,960	$249,572.00	
	14		0.512		172	$280,532	$30,960	$249,572.00	
	15		0.512		172	$280,532	$30,960	$249,572.00	

	16		0.512		172	$280,532	$30,960	$249,572.00	
	17		0.512		172	$280,532	$30,960	$249,572.00	
	18		0.512		172	$280,532	$30,960	$249,572.00	
	19		0.512		172	$280,532	$30,960	$249,572.00	
	20		0.512		172	$280,532	$30,960	$249,572.00	
						$5,268,130	$581,400	$4,686,730.00	

Figure 3a: Livelihood- Land Development

Data Points	Measure	Data Collection or Calculation
1. Land Type	FREEWAY Category	Identify type of land from Cranfield University FREEWAY Cost Model, such as grassy, hilly, or bush (Cranfield Mine Action 2003). Useful in transitioning to cost estimates.
2. Amount of Land	Km2	Determine amount of land cleared per year. If area of land is in another measure, for example Rai, in Thailand, one must convert the Rai to Km2.
3. Non-Agricultural Development	Use	Identify type of economic development, for example, business, industrial, market, etc.
4. Number of Market Vendors	Number	For this study, we have used the number of market vendors to estimate the increase in income per household. The village market manager provided this information. However, when data are available, another good measure is the volume of goods, (for example rice, mangosteen, or rambutan), that are sold over a year, and the revenue that they generate.
5. Average Value of Products Sold/Household	USD	The National Statistical Office of Thailand produces this data. For lack of regional data in English, this study uses the average for the country.
6. Monthly Expenses	USD	Each vendor pays $15 per month ($180/yr) for shop rental space. Again, the market manager provided this information.
7. Total Revenue	USD	Total Revenue = average value of products sold/household - monthly expenses.

8. Present Value	USD	Convert benefits to present value dollars. Present Value (PV) computation Discount rate (d) = .1, Stream of benefits suggested for 20 years. Net Production Revenue= future value (FV) See EXCEL Spreadsheet.

Land for Grazing

Herdsmen and livestock are frequently impacted by landmine accidents. The model has taken into account the value of risk reduction for humans, be they farmers or herdsmen. Let us briefly look at a methodology to calculate benefits for livestock saved. None of the field studies included valuing livestock. Therefore this example is from the "Socioeconomic Impact of Landmines: A Case Study of Eritrea and Ethiopia" by Taylor, Kombe, and Mitchell, 2001.

The Ministry of Defense for Sheraro Wereda in 1999 offered estimates of the losses in this area, Figure 4. Taylor, et al, note, "the loss of a single cow is a significant loss of wealth – nearly one-third of an Ethiopian's expected annual income" (Taylor 2001). Therefore, the value of livestock saved could have a major impact on the benefits projected in a cleared area.

Assumptions for Analysis: Ethiopia

- This impact analysis had exact numbers of livestock lost in a given year. For larger areas, or unknown losses, an estimate could be generated based on the average number of losses per Km2 in a given region.

Figure 4: Livelihood -- Land for Grazing

Year:	Amount of Land:	Livestock Lost:	Average number lost/year (1999):	Price of Livestock:	Value of Livestock Saved:	Total Value of Livestock Saved:	Present Value:
2003-2023	(Km2)	(Type)	(Number)	(USD)	(USD)	(USD)	(USD)
		Cows & Oxen	309	$191	$58,908	$60,884	
		Donkey	7	$184	$1290		
		Sheep	4	$25	$100		
		Goat	16	$25	$401		
		Camel	1	$184	$184		
Source of data: Taylor, Kombe, Mitchell 2001							

Forested Land

As noted in the discussion on Thailand, in some areas 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.

If in fact, foraging is an important source of income for residents in a project area, one could estimate income based on average sales of agricultural products per family, or equate family income to that of a subsistence level income in that region. See 3. Social, Land for Resettlement, for analysis of subsistence level incomes.

3. Social

Land for Resettlement

Benefits from resettling internally displaced persons (IDPs) 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.

Assumptions for Field Study Analysis: Marta, Ethiopia

- Project will clear 1.853 km2 in an area that supports a church, school, IDPs, and a road to Zala Ambessa.
- The land will be used for subsistence farming for those families returned to Tigray.
- The Rehabilitation and Development Organization (RaDO) has estimated that there are 7750 IDPs in the Marta area.
- The World Bank has approved an assistance package to support IDPs. It is a cash grant of 3-5,000 Birr for farm support, and 5-12,000 Birr for housing support.(Ato Gemada Aleme, ERP Mgt. Unit, 20/8/03)
- It is estimated that families take one trip per week to Zala Ambessa on the new road. This saves approximately 4-hours at a value of .46/hour. Because the estimate includes waking hours, that is leisure time and work time, the estimate was halved to .23/hour. The projected value of time saved was $47.84 per person each year.
- The estimated life of the project is ten years given the political instability of the border area.
- FINDING: Due to the significantly large number of IDPs served by the Marta project, the present value of benefits is $99,376,145.25.

Figure 5: Livelihood -- Land Resettlement

Country:	Year:	Amount of Land:	Land use: Susistence Farming:	IDPs:	Average IDP support from WB:	Donor dollars foregone with IDP resettlement:	Value of time saved with cleared road:	Total Benefits:	Net Present Value:
Ethiopia	2003-12	(Km2)	(Use)	(Number)	(USD)	(USD)	(USD)	(USD)	(USD)
					17000 Birr				
					USD=8.33900 Birr				
Marta		1.853	agriculture	7,750	2039	$158,022,500.00	$3,707,600.00	$161,730,100.00	$99,376,145.25
						10 years	10 years	10 years	10%, 10-yr
						$15,802,250.00	$370,760.00	$16,173,010.00	
						year 1	year 1	year 1	
	1	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	2	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	3	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	4	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	5	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	6	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	7	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	8	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	9	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
	10	1.853		7,750		$15,802,250	$370,760.00	$16,173,010.00	
						$158,022,500.00	$3,707,600.00	$161,730,100.00	

Figure 5a: Livelihood: Land for Resettlement

Data Points	Measure	Data collection or calculation
1. Amount of Land	Km2	Determine amount of land cleared per year. If area of land is in another measure, for example Rai, in Thailand, one must convert the Rai to Km2.
2. Land Use	Farming community facilities or infrastructure	Identify the intended purpose for the cleared land. In Marta, it was projected that the land would be reclaimed for farming as well as, a school, church, and a road to Zala Ambessa
3. Population Returned (IDPs)	Estimate	The Ministry of Economic Development, the Mine Action Office, program manager, or the local community can usually provide this data. One is looking for the best estimate of the population/IDPs returning to the cleared land.
4. Subsistence Support Intensity	USD	World Bank subsidy in Ethiopia is 3-5000 Birr for farm support, and 5-12000 Birr for Housing. Who is the source and what level of financial support will IDPs receive? Convert the price from the national currency to USD. See CURRENCYCONVERTER.COM
5. Donor dollars foregone	USD	To compute dollars saved once families have been returned: Donor dollars foregone = Number of IDPs x IDP subsistence support
6. Value of time saved with road clearance	USD	Estimate value of time saved when a cleared road improves accessibility to frequent destination points. For example in the Marta project, road was cleared to Zala Ambessa. One way to calculate this value: Determine number of hours/week saved based on distance of road cleared, estimated number of trips, and length of journey. Determine value of one hour of a person's time. E.g. Income/ waking hours(includes work and leisure time) Value time saved/person = Value of one hour X Number of hours/week saved X 52 weeks Value of time saved /project = Value of time saved/ person X IDPs returned
7. Total Benefits	USD	To compute: Benefits for Cleared Land = Donor dollars foregone with IDP return + Value of time saved

8. Present Value	USD	Convert benefits to present value dollars. Present Value (PV) computation Discount rate (d) = .1, Life of the project suggested for 10 years due to political instability of the region Net Production Revenue= future value (FV) See EXCEL Spreadsheet.

Social benefits also include improved access to education and health facilities. 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. Government statistics are the best source for these data.

There are notable indirect health consequences caused by landmines. The increase in waterborne diseases, primarily due to lack of access to safe drinking water; malnutrition because land cannot be cultivated; and infectious diseases because of the reluctance of vaccination teams to work in mined areas.(Kakar 1995) Therefore, when landmines have been cleared, the analyst can project social benefits for the residents of the area. 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.

4. Infrastructure

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,

Cleared road improvements are generally measured in terms of time saved by the restoration of safe passage. Using the average hourly wage for the area, multiply that by the amount of time required by the travelers to compute time saved from traveling around mined

areas for various purposes. The user must estimate the amount of traffic. This type of information can only be obtained locally although knowledgeable persons can estimate it. (See Section 3. Social, Land for Resettlement for an example, and Land for Resettlement Spreadsheet.)

For restoration or development of irrigation, one needs to know the increase in the productive value of land irrigated. Once a value is established, this information can be added to the value of the crop yield revenue in Section 2, Livelihood, Land for Crop Production. Again, see the Spreadsheet.

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.

It may also be possible to quantify the benefits to livelihoods caused by development or restoration of power sources. Again, increases in revenue generation, either livelihood, or goods and services, would need to be estimated. The benefits of residential housing can be estimated using property values (Byrd & Gildestad 2001).

Assigning quantitative values to socioeconomic impacts is never easy. However, in some projects, one can make a case for an economic impact on the area. There is also the possibility of considering the collaborative socioeconomic impact of projects that are sponsored by other agencies or NGOs. For example, simultaneous development of a health clinic, mine risk education program or a new hydroelectric power source could increase the impact of cleared land on the community. If these benefits are tangible, this information increases the understanding of the benefits of the project(s) as well as improving the probability that benefits will outweigh costs. CBA is a good tool. In these areas, it becomes more of an art than a science.

The next section is the easiest. Somehow, someone always knows the costs.

B. Costs

1. Capital

When decision-makers debate the value of a new project(s), capital costs often drive the direction of the decision. Large capital investments require access to resources, and consideration of the opportunity cost of investing that money for this project versus other needs in-country. Again, the CBA allows the user to look not only at costs, but to calculate the present value of the investment and compare this value to the projected present value of the benefits. Figure 6 presents an overview of typical cost considerations for a humanitarian mine action project. With regard to capital costs, for the projects under analysis, in-country capital investments were not a driving factor. Most of the landmine clearance was performed by manual and dog teams.

2. Operational

Operational costs must also be calculated. They are many and scattered, but most organizations have knowledge of that data. Obtaining a level of detail that is meaningful may be more difficult, but even gross estimates of clearance costs make the decision more transparent than it was the day before.

The in-country Mine Action Organization is usually a good source of costs. For example, the Thailand Mine Action Center (TMAC) had excellent data, and a very good estimate of what it was costing them to run their operation. Column one in Figure 6 depicts their budget categories. This information provided reliable data for the study. See the Spreadsheet that follows.

3. Donor Costs

Donor contributions of equipment will be forthcoming in Thailand, but did not have a direct impact on the projects studied. Obviously, donor contributions are important, and often omitted, when determining the ‘true’ cost of projects.

4. Education

Mine Risk Education is an element that is playing a more important role in decreasing landmine casualties. However, because education is funded by other organizations than the clearance money, or directed by different agencies, collaboration on information, objectives, and use of resources is still limited. It is suggested that analysts begin to incorporate, where reasonable, this cost data as an element of true project costs.

Figure 6: Landmine Clearance Costs

Operations	Capital	Donor Contributions	Education
Team Salaries (manual, dog, mechanical)	Equipment	Landmine Impact Survey	Mine Risk Education (MRE)
Equipment	Loans	Technical support	
Training		Training	
Medical care/deminer accidents		Equipment	
Fuel/transportation		Demining operations	
Communications			
Care for dogs			
Administrative overhead			

Assumptions for Field Study Analysis: Sa Kaeo, Thailand

- Data for this example drawn from Sa Kaeo experience in Thailand.
- One deminer team has 2 persons. One dog team has two dogs and two handlers. Estimate 8 teams altogether.
- Medical costs assume medical care and assistance for demining team members only.

- Fuel costs are for transportation purposes.
- Team members share equipment. Thailand prorates new equipment costs for team members on an annual basis. Heavy equipment costs would be included under capital expenditures.
- All costs estimates are based on data from the Thailand Mine Action Office. However, the author takes full responsibility for the use and interpretation of the data.
- Most work was performed by manual or dog teams.
- TMAC collected costs on an itemized basis by DAY and by RAIS. For purposes of this exercise, the cost/Rai was converted to a cost/Km2. Users of this template can use either cost to clear/km2, or itemized costs per day/month.
- Land type information will be helpful if the user employs the FREEWAY model to assist in the calculation of costs
- Costs for Chantaburi, Thailand, and Marta and Gerhusenay, Ethiopia are located in Annex 2.
- FINDING: Present value costs equal $3,277,192.23

Figure 7: Mine Clearance Costs

Country:	Yea:r	Land Area:	Land Type:	Cost/km2:	Cost to clear km2:	Expenditures			Tools, Equip., Commun.:	Medical Costs:	Fuel:	Dog Care:	Operational Costs:	Present Value:
						Manual:	Dog:	Equip.:						
Thailand	2003 -18	(Rai Km2)	(FREEWAY category)	(USD)	(USD)	(USD)	(USD)	(USD)					2198.29/rai 1,375,100.553 per km2	
Sa Kaeo		2940 rais = 4.7 km2	Grassy										$6,462,972.60	$3,277,192.23
													15 years	
	1	0.3133											$430,864.84	
	2	0.3133											$430,864.84	
	3	0.3133											$430,864.84	
	4	0.3133											$430,864.84	
	5	0.3133											$430,864.84	
	6	0.3133											$430,864.84	
	7	0.3133											$430,864.84	
	8	0.3133											$430,864.84	
	9	0.3133											$430,864.84	
	10	0.3133											$430,864.84	
	11	0.3133											$430,864.84	
	12	0.3133											$430,864.84	
	13	0.3133											$430,864.84	
	14	0.3133											$430,864.84	
	15	0.3133											$430,864.84	
		4.700											$6,462,972.60	

Figure 7a: Mine Clearance Operational Costs

Data Points	Measure	Data collection or calculation
		CONVERT ALL NATIONAL CURRENCIES TO US DOLLARS.
1. Salaries	USD	When possible, salary figures should include: ✓ salaries for manual, dog, and mechanical teams ✓ any per diem costs ✓ hardship pay
2. Tools, etc.	USD	Include costs: ✓ tools ✓ mine detectors ✓ protective equipment ✓ uniforms ✓ communications ✓ miscellaneous
3. Medical Costs	USD	Include costs: ✓ medical care ✓ prosthesis ✓ rehabilitation ✓ supplies necessary to sustain victim ✓ meals ✓ assistance in cash and in-kind
4. Fuel	USD	Fuel costs for transportation during operations.
5. Dog Care	USD	Costs associated with Dog Teams could include: ✓ Cost of using dog/day ✓ Dog food ✓ Dog medical expenses ✓ Kennel care – water, power, etc. ✓ Veterinary Technician and kennel staff

C. Comparing Benefits and Costs

Once the benefits and costs have been calculated, you can begin to do what you set out to do, and that is, offer the decision-maker a transparent analysis of the net benefits for the projects under study.

1. Net Present Value

As a refresher from the beginning of the manual, remember that net present value (NPV) combines several factors that influence the monetary value of a project. " By discounting any costs and benefits that will occur in the future, NPV considers the problem of time in evaluating the current value of the project to society. The formula for calculating the NPV would be

$$\frac{B_t - C_t}{(1 + d)^t} \ldots\ldots + \frac{B_n - C_n}{(1 + d)^t}$$

where Bt is the monetary value of benefits at time t, Ct is the monetary value of costs at time t, d is the discount rate, and n is the number of years of the project's life" (Sylvia, 1997).

When you have already discounted the individual benefits and costs, the NPV formula becomes

NPV = Total discounted benefits - Total discounted costs.

A project shows a return of benefits with a positive NPV. The CBA Model indicates a preferred project by illustrating which project has greater benefits than costs. The final spreadsheet depicts this calculation. The analysis for the field studies utilizes this formula.

If the user projects the same payment for the life of the project, the PV functional can be used. For the user that wants to project increasing or decreasing inflation rates, decreased costs, or increases in income/revenue over the number of years of the project, EXCEL provides the NPV function rather than the PV function. The benefits and costs must be entered for each year of the project and then discounted. For example, in the Sa Kaeo project, the estimated yield for crop production does not reach full return until year 15. (See Figure 2: Livelihood - Land Clearance for Crop Production.)

2. Field Examples

For purposes of this manual, the Sa Kaeo land clearance project for 210 farmers has been compared to the Chantaburi village market. The scale of the land clearance required, and the differences in the projected number of lives saved, as well as the probability that vendors will earn more than farmers make these difficult projects to compare. Nonetheless, the spreadsheet depicts the value of benefits accrued and costs to complete. For the Chantaburi project, benefits exceed costs. For Sa Kaeo, the inverse is true. However, the significance of returning farmers to the land, and supporting the National Plan that encourages self-sufficiency are difficult to measure quantitatively. For this reason, the Analytic Hierarchy Process in Section IV will let users take these intangible concerns and considerations into account.

Assumptions for Field Study Analysis: Thailand and Ethiopia

- All benefits and costs were discounted individually, then entered in a comprehensive spreadsheet. The spreadsheet totals present value benefits, and present value costs. The final NPV calculation occurs in Column K.
- FINDING:For the Sa Kaeo project costs exceed benefits by -$1,629,172.15. The Chantaburi project shows an NPV of $1,929,214.86. In present value dollars, Chantaburi would be the recommended project.
- FINDING: For the Marta project, there are present value dollar benefits exceeding costs by more than $98 M dollars. This is due in part to the greater number of IDPs served by this project, and the time saved by traveling the cleared road to Zala Ambessa The Gerhusenay project shows present value benefits exceeding costs by $7 M dollars.

Figure 8: Net Present Value: Thailand

Country:	Year:	Risk Reduction:	Land:	Land:	Land:	Social:	Infrastructure:	Present Value:	Present Value:	Net Present Value:
Thailand	2003-17	Lives /Injuries Saved; Medical Costs Foregone	Crop Yield	Grazing; Forested	Development Commercial Industrial	Resettlement, Schools, Health	Roads; Irrigation; Power; Water, Sewer; Housing	Benefits	Costs	Benefits - Costs
Sa Keao		$1,015,652.73	$632,367.35					$1,648,020.08	$3,277,192.23	-$1,629,172.15
	1		10,271.00							
	2		20,541.00							
	3		30,812.00							
	4		41,083.00							
	5		51,353.00							
	6		61,624.00							
	7		71,895.00							
	8		82,166.00							
	9		92,436.00							
	10		102,707.00							
	11		112,978.00							
	12		123,248.00							
	13		133,519.00							
	14		143,790.00							
	15		155,849.00							
	16		155,849.00							
	17		155,849.00							
	18		155,849.00							
	19		155,849.00							
	20		155,849.00							
Chantaburi		$109,601.32			$1,880,708.91			$1,990,310.23	$61,095.37	$1,929,214.86
	1				$171,296.00					
	2				189,072.00					
	3				208,464.00					
	4				229,472.00					

	5				252,096.00					
	6				277,952.00					
	7				277,952.00					
	8				277,952.00					
	9				277,952.00					
	10				277,952.00					
	11				277,952.00					
	12				277,952.00					
	13				277,952.00					
	14				277,952.00					
	15				277,952.00					
	16				277,952.00					
	17				277,952.00					
	18				277,952.00					
	19				277,952.00					
	20				277,952.00					

Figure 9: Net Present Value -- Ethiopia

Country:	Year:	Risk Reduction:	Land:	Land:	Land:	Social:	Infrastructure:	Present Value:	Present Value:	Net Present Value:
Ethiopia	2003-17	Lives /Injuries Saved; Medical Costs Foregone	Crop Yield	Grazing; Forested	Development Commercial Industrial	Resettlement, Schools, Health	Roads; Irrigation; Power; Water, Sewer; Housing	Benefits	Costs	Benefits - Costs
Marta		$174,031.42				$99,376,145.25		$99,550,176.67	$1,347,754.34	$98,202,422.33
						10%, 10years			10%, 5 years	
						includes roads				
Gerhusenay		$382,041.63				$9,146,003.80		$9,146,003.80	$1,750,105.38	$7,395,898.42
						10%, 10 years			10%, 7 years	

IV. Analytic Hierarchy Model

Given the limitations of the Cost-Benefit Analysis Model, there remains a need for an alternative approach to the prioritization of humanitarian mine action projects. The manual has noted that the CBA is a good decision tool to prioritize projects that have tangible costs and benefits. As the field study projects illustrated however, there are many projects where costs greatly exceed benefits, and there is no opportunity to evaluate the non-tangible benefits that the projects bring to the community and country.

In order to better evaluate those non-tangible benefits, the team suggests an alternative model called the Analytic Hierarchy Process (AHP). This decision-making technique was developed by Thomas Saaty (1980) to explicitly rank tangible and intangible factors against each other in order to establish priorities.

The AHP is a structured process that invites expert opinion in the ranking of proposed projects. This decision tool renders a decision and ultimately a policy recommendation that reflects the expert judgment garnered from subjective as well as quantitative input. Furthermore, the AHP application has proven itself very successful for years in the business world. For these reasons, the AHP is an alternative option for humanitarian mine action project prioritization.

Briefly, the AHP Model derives project priorities based on an assessment of multicriteria. First, the AHP Model structures a problem into a hierarchy of goals, criteria, and alternatives. Following the creation of the hierarchy, one constructs a pairwise comparison matrix of each factor, including criteria, and alternative projects. The expert group weighs each element against the other at every level. The beauty is that the entire process is linked mathematically and that the end product is a clear priority conclusion.

Participants, the expert group, or government officials can determine how well each alternative scores with respect to each criterion, and the relative importance of each criterion on a simple questionnaire. To the participant, the AHP Model is a simple, user-friendly process. No knowledge of the AHP Model is necessary to render subjective judgments.

A. The AHP Model in Practice

For those persons interested in the logic and mathematical underpinning of the model, this manual uses the Thailand project data to depict the AHP Model's effectiveness in an EXCEL spreadsheet. Commercial software gives more precise results as well as supporting sensitivity analysis. However, the manual process is not difficult, and it illustrates the methodology employed by off-the-shelf software. Follow the steps below.

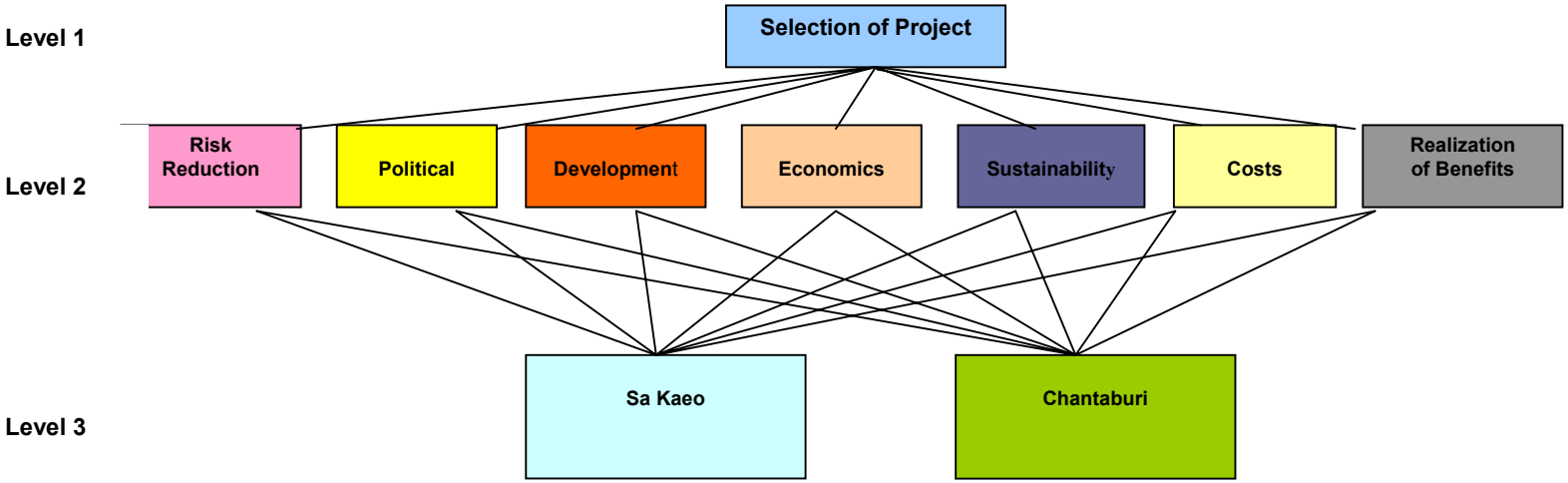
1. Develop a Hierarchy of Goals, Criteria, Alternatives
2. Assess Alternatives with Respect to Each Criteria
3. Assess the Relative Importance of Each Criterion
4. Evaluate the Consistency of the Model
5. Select the Best Project

1. Development of a Hierarchy of Goals, Criteria, Alternatives

In AHP, a problem is structured as a hierarchy consisting of the main goal, criteria thought to be important to that goal, and alternatives for satisfying those criteria. The main goal for a humanitarian mine action project prioritization exercise is to "select the best project." The criteria thought to be important to that goal can consist of tangible and intangible benefits. For example, as in the CBA, the user can consider costs, however, in AHP the cost of each project would be evaluated relative to the cost of the other projects. This means that AHP allows the user to consider other intangible criteria ranging from political stability, to supporting national goals, and self-sustainability. Field experience resulted in the development of the attached list of intangible benefits in Table3.

Table 3: 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

Figure 10:
Hierarchy



Once identified, these intangible benefits translate to criteria used to evaluate the alternative projects. Note that users can select their own criteria and might consider adding: support national goals; support community goals; meet treaty obligations, improve the quality of life for members of the community; and capacity building. [Note: If more than seven criteria are selected, then the criteria will need to be grouped and another level added to the hierarchy.] The user then identifies two to seven criteria as the basis for assessing the projects. Questions that relate to the country objectives can be used to understand the use of each criterion in the pairwise evaluation process. For the Thailand analysis the team chose a hierarchy (Figure 10) that included:

- Risk Reduction: does completing this project increase the number of lives saved? Reduce the number of injuries? Reduce national medical costs?

- Political Stability: what is the likelihood that this project will promote and improve political stability in the region?

- Development: does completing this project enhance development investment in the local area? Will this project provide accessibility, roads, schools, or other infrastructure facilities that promote future development?

- Economic Growth: does completing this project drive economic growth, an increase in income in the local village or region, or training transferable to other economic sectors?

- Quality of life: 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,?

- Costs: what is the cost of the project? When available, actual cost data can support the subjective judgment.

- Realization of Benefits: what is the likelihood that upon completion of this project the land will be used for the purpose intended? For example, IDPs returning, or farms cultivated, or lives saved.

And finally, the alternatives are the projects that one subjects to the prioritization process. In this analysis, we assess two projects:

- Land cleared for crop production at Sa Kaeo, Thailand
- Land cleared for a local market at Chantaburi, Thailand

2. Assessment of alternatives with respect to each criterion

To perform this step the users must do pairwise comparisons of Sa Kaeo and Chantaburi projects with respect to each of the criteria and enter the results in a matrix. For example, ask does one prefer the Sa Kaeo project or the Chantaburi project with respect to risk reduction benefits? And to what degree does one prefer one to the other? In other words, which project is expected to have a higher risk reduction benefit, and how much higher? The purpose of this step is to fill the cells in the matrix with scores that reflect the relative preferences of the expert group for the projects when considered only on the basis of one criterion.

In making pairwise comparisons, use the AHP rating scale in Table 4.

Table 4: 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.

If the users rate the risk reduction benefits of the projects as equal, then enter a score of 1 for each. However, if there is a very strong preference for the Sa Kaeo project over the Chantaburi project when the decision criterion is to save as many lives as possible, then enter a score of 7 in the Sa Kaeo row of the matrix. Then enter the inverse score or reciprocal of 1/7 into the Chantaburi row.

The manual includes an Excel template with formulas provided to automatically compute the relative rankings after the pairwise comparisons are entered for each criteria.. [Note: if the number of projects changes these formulas will need to be edited.] See Figure 11 to 17 and the accompanying Excel spreadsheet. The template formulas normalize each matrix by calculating the sum of each column and dividing each entry by its column sum. ***The average for each row, as seen in the SCORES column, becomes the relative score for each project with respect to the criterion being evaluated.*** The pairwise comparisons made for this analysis and the corresponding results are shown below.

Figure 11: Risk Reduction Pairwise Comparisons

Risk Reduction Pairwise 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

Figure 12: Political Stability Pairwise Comparisons

Political Stability Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	1.000	
Chantaburi	1.000	1.000	
Sum	2.000	2.000	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.500	0.500	0.500
Chantaburi	0.500	0.500	0.500

Figure 13: Development Goals Pairwise Comparisons

Development Goals Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	5.000	
Chantaburi	0.200	1.000	
Sum	1.200	6.000	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.833	0.833	0.833
Chantaburi	0.167	0.167	0.167

Figure 14: Economic Benefits Pairwise Comparisons

Economic Benefits Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	0.200	
Chantaburi	5.000	1.000	
Sum	6.000	1.200	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.167	0.167	0.167
Chantaburi	0.833	0.833	0.833

Figure 15: Quality of Life Pairwise Comparisons

A. Quality of Life Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	9.000	
Chantaburi	0.111	1.000	
Sum	1.111	10.000	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.900	0.900	0.900
Chantaburi	0.100	0.100	0.100

Figure 16: Cost Pairwise Comparisons

Costs Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	0.143	
Chantaburi	7.000	1.000	
Sum	8.000	1.143	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.125	0.125	0.125
Chantaburi	0.875	0.875	0.875

Figure 17: Realization of Benefits Pairwise Comparisons

Realization of Benefits Pairwise Comparisons			
	Sa Kaeo	Chantaburi	
Sa Kaeo	1.000	0.143	
Chantaburi	7.000	1.000	
Sum	8.000	1.143	
	Normalized Comparisons		
	Sa Kaeo	Chantaburi	Scores
Sa Kaeo	0.125	0.125	0.125
Chantaburi	0.875	0.875	0.875

3. Assessment of the relative importance of each criterion

Before the final weighting formula can be applied, one must determine the relative importance of each criterion. Again, ask questions, when ranking these projects, about which criterion is relatively more important in evaluating projects (e.g., the impact of risk reduction or the impact of political stability). And to what degree is one criterion more important than the other? For example, the expert evaluators address which criterion is more important in judging a project - preventing injuries or promoting political stability. The question to be asked here is: How do these two projects compare in their contribution to the overall goal of choosing the most effective mine clearance project?

This part of the process compares each criterion to every other criterion. As in the earlier pairwise matrices, simply enter the importance value from the pairwise comparison scale in the appropriate row and enter its reciprocal in the appropriate cells. Because these entries change with every prioritization process, there are no pre-written cell formulas. Data entry is a short-term manual process here.

For the criteria level of the hierarchy, only a single matrix is needed. For example, in the Criterion spreadsheet, (Figure 18), the score of 3 in Risk reduction row under Political stability indicates that risk reduction is considered to be moderately strongly more important than political stability as a criterion in ranking these projects. The reciprocal score of 1/3 is entered in the inverse position in the matrix. The Criteria Pairwise Comparison Spreadsheet also contains formulas to automatically compute the normalized values and average the row scores to determine the weight of each criterion..

These weights provide a measure of the relative importance of these intangible benefits in identifying the best project, based on input from the expert group members.

Figure 18: Criteria Pairwise Comparisons

Criteria Pairwise Comparisons									
	Risk Reduction	**Political Stability**	**Development Goals**	**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							**Criterion**	**Consistency**
	Risk Reduction	**Political Stability**	**Development Goals**	**Economic**	**Quality of Life**	**Costs**	**Realization**	**Weight**	**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

4. Evaluate the Consistency of the Model.

Before proceeding with the prioritization process, it is wise to confirm that the group has been consistent in its judgments. The spreadsheet computes a consistency measure for each criterion with respect to every other criterion. It also computes a consistency ratio (CR), which informs the user whether there is an excessive amount of inconsistency in the set of pairwise comparisons.

For a mathematical explanation of these measures, refer to Ragsdale. The formulas are

$$\text{Consistency Index or Measure (CI)} = \frac{\lambda - n}{n - 1}$$

$$\text{Consistency Ratio (CR)} = \frac{CI}{RI}$$

where:

λ = the average consistency measure for all alternatives
n = the number of alternatives
RI = the appropriate random index from the values of RI for AHP table (Ragsdale Year)

Random Index

n	2	3	4	5	6	7
RI	.00	.58	.90	1.12	1.24	1.32

The Excel formulas for these computations can be viewed in the cells. ***For our purposes, it is important to know that a CR value of 0.10 or less is considered acceptable. A CR value that is greater than 0.10 may suggest significant inconsistencies in the judgments.*** If inconsistency is unacceptable, re-working pairwise entries such that they are closer in ranking can usually reduce the CR value. Note that if there were more than two projects being evaluated, a CR should also be computed for the pairwise comparisons on each of the criteria spreadsheets.

5. Select the best project.

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. The Final Scores spreadsheet calculates the ***weighted average score for each project*** . It takes the ***scores for each alternative with respect to each criterion, multiplies the score by the criterion weight, and sums the products for each alternative.***

Figure 19: Final Score Sheet

FINAL SCORE SHEET

Criterion	Sa Kaeo	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 Average Score	0.535	0.473	1.008

The prioritization of the projects has been completed. The AHP Model has determined the best project based on the subjective input of country experts, donors, or other select participants. The result reflects the best alternative given the criteria that the model used for analysis. The hierarchy goal, to offer decision makers a prioritization of the projects under consideration, has been met.

Sa Kaeo	0.535
Chantaburi	0.473

FINDING: In the study that we have used as an illustration, the Sa Kaeo project ranks higher (0.535) in the model analysis than the Chantaburi project (0.473). The evaluation of intangible criteria illustrates that in reality, the objectives met by the projects are much closer than the differences depicted by a quantitative model such as the CBA.

FINDING: The AHP Model offers an opportunity for collaboration among expert participants in determining the preferred project.

ANNEX 1

EXAMPLES OF MEASURES, DATA POINTS, AND SOURCES FOR A COST-BENEFIT MODEL TO PRIORITIZE MINE ACTION ACTIVITIES

Examples of Measures, Data Points, and Sources for a Cost-Benefit Model to Prioritize Mine Action Activities			
DIRECT TANGIBLE	MEASURE	DATA POINTS for CALCULATION	SOURCES
Risk Reduction	Gross Domestic Product/Purchasing Power Parity (GDP/PPP) for Productive Population	GDP/PPP	World Bank Development Report
		Productive population	National Statistical Office, Office of the Prime Minister, Thailand
		Informal sector	
		Lost leisure	Byrd & Gildestad 2001
		Age cohorts	
		Proportion of losses	Landmine Impact Surveys
		Years of productive labor	
		Discounted value production	United Nations Human Development Report
		Unemployment discount	
		Discounted value leisure	Local and regional government officials
		Leisure loss relative share	
Risk Reduction	Medical costs foregone @ death	Productive population	Hospital
		Hospital charges	Community
		Burial	NGO
Risk Reduction	Medical costs foregone for treatment of injury	Productive population	Hospital
		Hospital charges	Clinics
		Prosthesis	Donors
		Rehabilitation	LIS
		Age cohorts	Ministry of Economic Development

I. DIRECT TANGIBLE	MEASURE	DATA POINTS for CALCULATION	SOURCES
Cleared Land: Crop Yield;	Value of yield	Crop	Ministry of Agriculture
Irrigation		Amount of land cleared Harvest yield Crop intensity Market or farmgate price Input factors Yield differentials with irrigation	National Statistics Office
Cleared Land: Grazing	Value of Livestock	Types of livestock	Ministry of Agriculture
		Livestock lost Amount of land in Km2 Value of each type of livestock	National Statistics Office
Cleared Land: Commercial	Increase in product sales; or increase in household income	History of region/district/village product sales Current product sales data	Ministry of Economic Development or Commerce; National Statistical Office
Social Factors:	Costs foregone for support of Internally Displaced Persons (IDPs) and subsistence farmers	Number of IDPs or farmers resettled	FAO
Resettlement		Contribution per family for subsistence Contribution per farmer for farm operation	Mine Action Organization NGOs
II. DIRECT TANGIBLE	**MEASURE**	**DATA POINTS for CALCULATION**	**SOURCES**
Cleared Land: Residential			Mine Action Organization
	Increase in property values	Amount of land reclaimed	NGOs

		No. units devel/amt of land Value of Km2 Value of structures	
Health	Infant mortality	Hospital/clinic capacity Increase in population treated for: landmine accidents, malnutrition, tuberculosis, HIV-AIDS, maternal and child health	Mine Action Organization Hospital/clinic
Education	Students enrolled Graduates	Built/rebuilt school capacity Student enrollment Graduates Potential for increase in income Accessibility to school. For example: travel time, cleared roads	Mine Action Organization Community leaders
Infrastructure:			
Water and sewerage facilities	Costs foregone for deaths, treatment of dysentery, cholera	Value of time saved to obtain water	National Mine Action Organization
	Infant mortality	Costs to treat dysentery, cholera, etc. Incidence of disease Infant mortality Average income	Ministry of Economic Development NGO
III. DIRECT TANGIBLE	**MEASURE**	**DATA POINTS for CALCULATION**	**SOURCES**
Roads	Value in time saved	Number of meters cleared adjacent to roads Roads constructed Value of reduced travel time Average income Increase in number of travelers Increase in market sales	National Mine Action Organization Ministry of Econ. Devel. NGO

COSTS			
DIRECT TANGIBLE	**MEASURE**	**DATA POINTS for CALCULATION**	**SOURCES**
Operations	Land Clearance Costs	Team salaries (manual, dog, mechanical) Land type clearance cost differentials Number of days for project Number of square meters cleared Equipment Communications Training Medical care/deminers Fuel/transportation Care for dogs Administrative overhead	National Mine Action Org.
Capital	Investment costs	Equipment costs Loans Years of depreciation Discount rate	National Mine Action Org NGO
Education	Number of persons receiving mine risk education OR number of persons that change their behavior because of MRE	Number of persons that receive MRE	UNICEF
		Behavior change as determined by pre- and post-survey results of persons that receive MRE	NGO
Cost Continued			
DIRECT TANGIBLE	MEASURE	DATA POINTS for CALCULATION	SOURCES
Donor Contributions	Grants	Landmine Impact Survey	Survey Action Center SAC
		Technical support Training Equipment Demining operations	National Mine Action Org. NGOs

ANNEX 2

PROJECT SPREADSHEETS NOT INCLUDED IN THE TEXT

Risk Reduction: Chantaburi, Thailand

Country/ Project	PPP (thousands)	Productive population	Lost Productivity wages	Informal Sector/ Leisure	Lost Productivity total	Cohort	Yrs of productive labor	Discount rate	Discounted value Production	Absolute value	Employment rate	Unemployment discount	No. of deaths/ Injuries	Relative productive value	Total productive value
Thailand Chant	391,700,000	33,342,400	11,748	100	11,848	<18	40	0.1	($115,860.28)	$115,860.28	97.4%	$112,847.91	0.00	$0.00	$108,784.35
						18-40	30		($111,688.24)	$111,688.24		$108,784.35	1.00	$108,784.35	
						>40	10		($72,799.63)	$72,799.63		$70,906.84	0.00	$0.00	
Injuries	Primary assistance	Wheel chair	Prostheses	Support											
	$107.41	$105.52	$126.77	$694.44											
Discounted	-$816.97	-$802.59	-$964.22	-$5,281.97											
Absolute value	$816.97	$802.59	$964.22	$5,281.97											
Victims	1	0	0	0											
Totals	$816.97	$0.00	$0.00	$0.00											
Grand total Medical	$816.97														
Total Benefits	$109,601.32														

Risk Reduction Marta, Ethiopia

Country/ Project	PPP (thousands)	Productive population	Lost Productivity wages	Informal Sector/ Leisure	Lost Productivity total	Cohort	Yrs of productive labor	Discount rate	Discount value Production	Absolute value	Emp. rate	Unemp. discount	No. of deaths/ injuries	Relative Production	Total Production
Ethiopia/ Marta	48000000	31534000	1522	0	1522	<18	40+(10)	0.1	5738.94	$5,738.94	100.00%	$5,738.94	6	$34,433.67	$91,831.00
						18-40	30		($14,349.33)	$14,349.33		$14,349.33	4	$57,397.34	
						>40	10		($9,353.05)	$9,353.05		$9,353.05	0	$0.00	
Injuries	Primary assistance	Wheel chair	Prostheses	Support											
Cost	$25.82			$1,507.00											
Discounted	-$196.39	$0.00	$0.00	-$11,462.36											
Absolute value	$196.39	$0.00	$0.00	$11,462.36											
Victims	10	0	0	7											
Totals	$1,963.89	$0.00	$0.00	$80,236.53											
Grand Total (Medical)	$82,200.42														
Total Benefits	$174,031.42														

Risk Reduction: Gerhusenay, Ethiopia

Country/ Project	PPP thousands	Productive population	Lost Prod. wages	Informal Sector/ Leisure	Lost Prod. total	Cohort	Yrs of producti ve labor	Discount rate	Discounted value Production	Absolute value	Employment rate	Unemployement discount	No. of deaths/ injuries	Total production lost	Total Prod. Value
Ethiopia/ Ger	48,000,000	31,534,000	1,522	0	1522	<18	40+(10)	0.1	5738.94	$5,738.94	100.00%	$5,738.94	10	$57,389.44	$172,184.12
						18-40	30		($14,349.33)	$14,349.33		$14,349.33	8	$114,794.67	
						>40	10		($9,353.05)	$9,353.05		$9,353.05	0	$0.00	
Injuries	Primary assistance	Wheel chair	Pros-theses	Support										$172,184.12	
Cost	$25.82			$1,507.00											
Disc.	-$196.39	$0.00	$0.00	-$11,462.36											
Absolute value	$196.39	$0.00	$0.00	$11,462.36											
Victims	18	0	0	18											
Totals	$3,535.00	$0.00	$0.00	$206,322.51											
Grand Total: Medical	$209,857.51														
Total Benefits	$382,041.63														

Costs: Chantaburi, Thailand

COSTS of MINE CLEARANCE															
						TEAM Expenditures									
Country	**Year**	**Land Area**	**Land Type**	**Cost/km2**	**COST to CLEAR Km2**	**Manual**	**Dog**	**Equipment**	**Tools, Equip. Comm.**	**Medical Costs**	**Fuel**	**Dog Care**	**Operational Costs**	**COSTS**	
Thailand	2003-2023	**Rais**	**FREEWAY Category**	**USD**	**USD**	**USD**	**USD**	**USD**					**2198.29/rai**	**Present Value**	
		Km2= 32 rais													
Chantaburi		0.0512 km2	Grassy										70,345.28	($63,950.25)	
														10%, 2 yrs	0.05
															0.12
													70,345.28		1

Cost: Gerhusenay, Ethiopia

COSTS of MINE CLEARANCE																
							TEAM Expenditures									
Country	**Yr**	**Land Area**	**Land Type**	**Cost/km2**	**Cost/km2**	**COST to clear**	**Manual**	**Dog**	**Equip.**	**Tools, Equip. Comm.**	**Med. Costs**	**Fuel**	**Dog Care**	**Operational Costs**	**COSTS**	
Ethiopia		**Km2**	**FREEWAY Category**	**Birr**	**USD**	**USD**	**USD**	**USD**	**USD**					**USD/km2**	**Present Value**	
Gerhusenay			Unknown		1USD= 8.339 birr											
		2.623		8,000,000	$959,347.64	2,516,368.86								$2,516,368.86	($9,539,017.78)	($6,257,836.91)
															$9,539,017.78	$6,257,836.91
															10%, 5 yrs	0.05
																0.12
																3
																10

Cost Risk Reduction Marta, Ethiopia

COSTS of MINE CLEARANCE																
							Expenditures									
Country	**Year**	**Land Area**	**Land Type**	**Cost/km2**	**Cost/km2**	**Cost to clear**	**Manual**	**Dog**	**Equipment**	**Tools, Equip. Commun.**	**Medical Costs**	**Fuel**	**Dog Care**	**Operational Costs**	**COSTS Present Value**	
Ethiopia		**km2**	**FREEWAY category**	**Birr**	**USD**	**USD**	**USD**	**USD**	**USD**	**USD**	**USD**	**USD**	**USD**	**USD**		
Marta	2003-05	1.853	unknown	8,000,000	959,347.64	1,777,671.18								$1,777,671.18	($4,420,805.11)	($6,408,106.77)
															10%, 2 Years	0.05
																0.12
																3
																5