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Cost-Benefit Analysis of Mine Clearance Operations in Cambodia

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Final Report (February 2005): Bjørn Gildestad

Preamble

This Cost-Benefit Analysis of Mine Clearance Operations in Cambodia was initiated by the Cambodian Mine Action and Victim Assistance Authority (CMAA) in cooperation with the United Nations Development Programme (UNDP) and carried out during the period November 2004 to February 2005. The author of the report is Mr Bjørn Gildestad of Nordic Consulting Group (NCG), Oslo, Norway bjogil@online.no

The study was completed with input and advice from a number of persons at CMAA, UNDP and other institutions and organisations in Cambodia (see list of contacts in Annex 2). To all these the author would like to express his thankful appreciation for the interesting cooperation and the valuable information supplied. A particularly active support was provided by the Senior Adviser UNDP/CMAA Mr Dominique Pierre Guéret and the Mine Action and Aid Coordination Specialist at UNDP Phnom Penh Mr Julien Chevillard.

Many persons have contributed to the report in various ways; still the responsibility for any factual inaccuracies or errors in the analysis rests entirely with the author. Furthermore the views, opinions and conclusions expressed should not be attributed to any other person or institution.

Map of Cambodia

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Abbreviations

ADB:	Asian Development Bank
APMBT:	Anti Personnel Mine Ban Treaty
BCR:	Benefit-cost Ratio
CBA:	Cost-benefit Analysis
CMAA:	Cambodian Mine Action and Victim Assistance Authority
CMAC :	Cambodian Mine Action Centre
CMDG:	Cambodian Millennium Development Goals
CMVIS:	Cambodia Landmine/Uxo Victim Information System
CRC:	Cambodian Red Cross
DAC:	Disability Action Council
EOD:	Explosive Ordnance Disposal
FAO:	Food and Agriculture Organisation of the United Nations
GDP:	Gross Domestic Product
GICHD:	Geneva International Centre for Humanitarian Demining
HI:	Handicap International of Belgium
ICBL:	International Campaign to Ban Landmines
ICRC:	International Committee of the Red Cross
ILO:	International Labour Organisation
IRR:	Internal Rate of Return
IMSMA:	Information Management System for Mine Action
KMAS:	Khmer Mine Action Service
L1S:	Level One Survey
LUPU:	Land Use Planning Unit (provincial level)
MAAB:	Mine Action Advisory Board
MAG:	Mines Advisory Group
MAPU:	Mine Action Planning Unit (replacing LUPU)
MDD:	Mine Detection Dogs
MDG:	Millennium Development Goals
MRE:	mine risk education
NMAD:	National Mine Action Database
NMAS:	National Mine Action Strategy
NPA:	Norwegian People’s Aid
NPRS:	National Poverty Reduction Strategy
NWP:	National Work Plan
PMAC:	Provincial Mine Action Committees
PRDC:	Provincial Rural Development Committee
PSC:	Provincial Sub-Committees
RCAF:	Royal Cambodian Armed Forces
RGC:	Royal Government of Cambodia
TRIP:	Tertiary Roads Improvement Programme
UNDP:	United Nations Development Programme
UNTAC:	United Nations Transitional Authority of Cambodia
Uxo:	Unexploded ordnance
VOC:	Vehicle Operating Costs

Executive Summary

Cambodia is seriously affected by landmines and unexploded ordnance (Uxo), due to almost three decades of various armed conflicts in the latter part of the twentieth century. Landmines and Uxo explosions are claimed to have caused more than 60,000 victims since 1979. In 1996 the number of casualties rose as high as 4313, out of which the civilian share was 40%, 772 persons were injured or killed in 2003 and 891 in 2004. In addition to the accident risk, mines and Uxo also constitute a significant obstacle to rehabilitation and development activities in many areas.

Mine action resources have to be carefully managed to respond to national humanitarian and development priorities. Besides humanitarian imperatives mine action in Cambodia has a crucial role to play in supporting the socio-economic development and poverty reduction strategies set by the Royal Government (RGC). However, little information about the socio-economic benefits of mine action has so far been collected.

This cost-benefit analysis (CBA) of mine clearance operations in Cambodia was launched by the national regulatory and coordinating body, the Cambodian Mine Action and Victims Assistance Authority (CMAA) in cooperation with UNDP. The socio-economic benefits of mine action will be assessed covering the period since the start of the programme in 1992, and a cost benefit analysis model developed for the use of the RGC and stakeholders involved in mine clearance.

Cambodia staged aggressive economic growth between 1993 and 1996, but ongoing civil strife, domestic political instability, the Asian financial crisis, and the failure of the government to implement necessary policy and legal reforms sharply slowed down economic activities and foreign investment. Thus about 36 % of the population still lives in absolute poverty, lacking the necessary minimum level of 2100 calories per person per day. Livelihood systems are not secure in particular for most rural communities, which comprise predominantly subsistence farmers. An estimated 60 % of the households there suffer from food deficits. Cambodia's land problems are particularly acute. During the years with war and conflicts hundreds of thousands of people were displaced, entire families were wiped-out, and different groups obtained overlapping claims to the same land or its resources.

The mine/Uxo problem is still serious even though the number of mine victims is decreasing. Uxo victims, however, now constitute more than 50% of the casualties and the number is rising. About 70% of the mine victims are exposed to accidents while travelling, doing farm work or collecting wood, whereas 59% of the Uxo victims were tampering with the Uxo, while another 18% were lookers on. Males are much more frequently exposed to mine and Uxo accidents then females. Men and boys constitute 88% of the total number of casualties. At mine accidents 80% of the victims are men and 11% boys, Uxo incidents, however, involve just as many boys as men.

The extent of the mine/Uxo infested area in Cambodia is disputed; in particular which parts of it that should be given priority for clearance. It is strongly recommended to revise the estimates of contaminated area.

Mine action is considered by the RGC as one of the top priorities for rehabilitation and development of the country. It has been fully integrated among Cambodia's Millennium Development Goals and in its Poverty Reduction Strategy. The Kingdom of Cambodia is committed to the Ottawa Convention on the ban of landmines

The Cambodian National Mine Action Strategy 2004 states that clearance of the worst-affected areas will be given priority to reduce as soon as possible the risk of death or injury to individuals living in landmine/Uxo -affected areas. The goal is to clear the remaining parts of the severely contaminated land by 2012-2015, while targeting a decrease in the number of mine and Uxo accidents towards a minimum at the end of the same period. Realistically it is anticipated, however, that mine action operations will need to continue even beyond 2020.

It is also admitted that while the clearance of minefields can reduce the number of mine accidents, other measures like mine risk education will have to be strengthened in order to reduce the number of Uxo casualties. From 1992 to December 2003 the various mine clearance operators had cleared a total area of about 252 km^2.

The mine action strategy distinguishes between clearance of severely mined villages with high levels of casualties, and providing access to productive land improving the living conditions for poor people, de-mining of specific areas such as historical sites to promote development of the tourist industry, or clearing infrastructure such as roads allowing communication with other parts of the country. The programme aims at putting in place a community based, transparent, participative and decentralized process to identify those villages, families and persons that will be entitled to receive cleared lands.

The appraisal of the gains from mine action towards reduced human loss are based on calculations of the potential contributions from an average Cambodian mine victim to the productive activities of the country. This must not, however, be conceived of as the value of a human life. Still it is in line with benefit calculations regularly undertaken by other types of initiatives aimed at saving lives and reducing accidents risk.

The agricultural land cleared under the Cambodian mine action programme is specifically destined for distribution among the poorest parts of the population. The staple food item in Cambodia is rice. The output from rice production will therefore be used as a guideline for the production value, also including livestock production as a complementary trade. Mine clearance related to irrigation canals and systems aims at reopening the possibility for irrigation of agricultural areas. Clearance of a canal area can thus benefit a much wider extent of agricultural land.

These are indications that landmine damage to domestic animals might constitute a significant economic loss. This could call for an improved reporting system.

Clearance of roads will benefit the road users providing more convenient transport opportunities, reduced travel time and travel costs. Mine-contaminated road links may generally hinder road users from travelling the shortest route to their destinations. Clearance of wells, school areas and health stations will in the same way provide user benefits from the reduced need for travelling to alternative facilities in more distant locations. Clearance of historical sites and temples are evaluated as of their capacity to create more revenues to the country from the tourist industry.

Four agencies are currently involved in the mine action programme in Cambodia. There is little standardization among the operators as of the approach to the tasks, the set-up of teams for the field work, techniques and types of equipment in use. Competition among the operators is limited, as there is no regular practice of putting larger clearance tasks out on tender. Each operator to a large extent benefits from its proper and regular sources for funding

The operators should be required to provide better data on the cost of conducting mine action activities. Some operators are in the process of developing their accounting procedures, which could result in better cost-estimates with more details on costs of clearing different types of

areas, with various approaches and techniques etc, information which to a large degree is non-existent now.

Mine action is contributing substantial values to the Cambodian economy and the country in general. Analysis of the 2004 clearance programme comes out with a benefit cost ratio (BCR) of 0.38, implying that benefits are in general 38% higher than the costs, on basis of an average clearance cost rate of US$ 0.9 per m^2. The internal rate of return will on the same assumptions be 14%.

The benefits amount to about US$ 37 million in total, distributed with 80% on clearance for development and 20% on the reduced human loss. Roads and bridges make up the largest parts with 45%, even though such clearance tasks only comprise 19% of the total area cleared. Smaller size tasks related to irrigation canals also contribute considerably. For agricultural land the situation is inverse, it constitutes as much as 65% of the cleared area while making up 28% of the benefits.

The benefits from renewed access to more direct road links can be considerably larger that the costs generally required for clearance. Clearance of roads and bridges could thus be undertaken also in cases of relatively high cost levels. The benefits from renewed access to wells for local water supply, schools and health stations have likewise few difficulties with justifying clearance, on basis of the reduced travel time and travel costs for the users and the pupils.

These are excellent candidates in a development perspective, and such tasks should be given priority as far as benefits in economic terms are concerned. It is evident that the programme benefits could be enhanced by diverting more of the clearance activity towards rural infrastructure like roads, water supply, schools etc, and also to sites attracting tourism.

The output per ha of arable land is on the average rather moderate in Cambodia. Yet the main conclusion is not that clearance of agricultural areas is unprofitable. There is, however, a call for conscious prioritization, a planning process capable of identifying those areas and tasks that are of highest importance to the local communities.

In the agricultural sector a high priority should be given to the reopening of irrigation systems permitting dry season cultivation of arable land. Benefits could here be extensive and have important consequences for the rural economy and for food production.

Clearance for casualty reduction also needs to be well targeted in most cases and locations in order to have the desired effect. Improved assessments could be made of which parts of the extensive mined area in the country that are generating the bulk of the mine/Uxo accidents, representing a danger to the people now and in future years with expected population movements etc. In spite of the excellent statistics on mine/Uxo casualties and incidents in Cambodia, there are lacking elements in the analysis that could help direct the clearance activity towards the most risky locations.

Programme benefits cover clearance costs in all provinces. The 4 provinces of Battambang, Odtar Meanchey, Banteay Meanchey and Preah Vihear collect the bulk (78%) of the benefits from the 2004 clearance programme. The benefit-cost ratio (BCR) is, however, highest in Kampong Cham and Pailin. The main part of the benefits comes from gains related to economic development. Still the reduced human loss is an essential factor, contributing to increase the programme benefits particularly in Pailin.

Mine action's contribution in the years 1992-2003 to increase the country's paddy production could amount to over 50,000 tonnes annually. This production increase has been made possible on reclaimed agricultural land and through renewed access to irrigation canals. This

constitutes in general a 3% growth in paddy production in the mine action regions, but could be even more important for food security in provinces like Pailin, Kep, Banteay Meanchey and Battambang.

A transparent and equitable system for redistribution of the reclaimed land is an important goal under the mine action programme. The cleared areas may have provided land and contributed to improve land security for about 160,000 families over the period 1992-2003, that is to say for over 13,000 on the average each year.

Clearance of water supply systems and rural wells has improved the access to safe drinking water in rural areas. An estimated 1400 wells and ponds have been cleared in the course of the mine action programme 1992-2003.

De-mining school premises contributes to improving the education system so that more children can be able to complete school. Mine clearance is also frequently required to provide access to rural health stations, which are much needed in the fight against the spread of diseases and to reduce child and maternal mortality. It is estimated that about 60 health stations have been cleared under the mine action programme.

There are indications that landmine damage to domestic animals might constitute a significant economic loss. This could call for an improved reporting system, if possible through CMVIS.

The extent of the mine/Uxo infested area in Cambodia is disputed; in particular what parts of it should be given priority for clearance. It is strongly recommended to revise the estimates of the contaminated area.

The CMAA database on cleared areas needs to be consolidated, so that it can provide official figures for clearance on location (province, district), types of areas, techniques etc for the individual years since the start of the mine action programme. As of today this information exists on different files which can be incomplete and inconsistent.

The operators should be required to provide better data on the cost of conducting mine action activities. As a first approach more information about clearance time (in hours) of different types of tasks and areas could be demanded.

A library or Information and Documentation Centre should be established at CMAA to secure the institutional memory.

Annex 1 contains some straightforward methods, based on cost-benefit analysis, to be applied as instruments for assessing socio-economic and poverty reduction impacts of future mine clearance operations. The approach is based on data presented and methods developed in the previous parts of the report.

The CMAA Socio-economic Cluster should in particular have a responsibility with following up the cost-benefit analysis.

1. Introduction

1.1 The mine/Uxo problem

Cambodia is seriously affected by landmines and unexploded ordnance (Uxo), due to almost three decades of various armed conflicts in the latter part of the twentieth century. Landmines and Uxo explosions are claimed to have caused more than 60,000 victims since 1979. In 1996 the number of casualties rose as high as 4313, out of which the civilian share was 40%. Of the 772 persons injured or killed in 2003 and the 891 in 2004 almost all were civilians. One third of the victims were children in the countryside, especially in areas considered indispensable for new settlement of poor people.

Cambodia was heavily bombarded by the USA between 1969 and 1973 in connection with the Vietnam war, approximately 2.4 million tons of bombs were dropped over the country. During the Khmer Rouge period 1975-79 virtually all well-educated Cambodians were killed or forced into exile. Eventually, an estimated 1.5 million Cambodians, or one in six died from execution, starvation, or disease before the overthrow of the regime by Vietnam, the former ally of the Khmer Rouge.

The country lost almost an entire generation of its educated people and many war-affected groups, internally displaced people and returning refugees, widows, orphans, child combatants, remain acutely vulnerable. An estimated one person in 250 is disabled, and war plus the ongoing scourge of landmines have resulted in the highest proportion of amputees (one in 384) recorded in the world. The war period left Cambodia with between four and six million mines and millions of Uxo in the ground. In addition to the accident risk, mines and Uxo also constitute a significant obstacle to rehabilitation and development activities in many areas. This situation prevails despite the fact that mine action programmes covering clearance, marking, awareness rising and training have been going on since 1992, resulting in clearance of 251 km^2 of land so far.

According to the Level One Survey (L1S) from 2002, about 12% of the villages in Cambodia have to cope with high contamination of landmines and Uxo. The problem is severe and access to essential facilities such as water, roads, bridges and cultivable land is restricted and hazardous for many rural civilians. Still it has been recognized that the L1S estimates for contaminated land were too high. Preliminarily a share of 10% of the L1S figures has been proposed as reflecting the actual situation (2004), comprising 425 km^2 of contaminated land, out of which about 300 km^2 have been given the highest priority.[1] Data from the operators suggest a priority area of 260 km^2.

Uxo victims have over the last years constituted more than 50% of the victims. While people are exposed to mine accidents during farm work, collecting wood or travelling, the majority of the Uxo victims were actually tampering with the Uxo. This fact raises the question to what extent clearance of contaminated areas can contribute to alleviate the risk of Uxo accidents.

The overall development goal of the mine action programme is to reduce the level and impact of land mine/Uxo contamination in Cambodia in a transparently prioritised, cost effective and safe manner, so that the maximum number of people, predominantly rural but also urban, can go about their lives free from the threat of land mines/Uxo thus permitting reconstruction, reintegration and development activities to take place in a safe environment. The National Mine Action Strategy 2004 states that Cambodia has a long-term mine & UXO problem, which will require national striving in mine action for the next two decades. The medium-

[1] See chapter 3.1.

term vision is to move towards zero impact from land mines and UXO by 2012, the long-term vision is to have a Cambodia free from the negative humanitarian and socio-economic impacts of landmines/ UXO by 2020. Cambodia is a state party to the Anti Personnel Mine Ban Treaty (the Ottawa Convention).

The Cambodian Mine Action and Victims Assistance Authority (CMAA) was established in September 2000, replacing the Cambodian Mine Action Centre (CMAC) as the national coordinating and regulatory body in charge of mine action management and policy development. UNDP program support to CMAA started in 2001. Other agencies operating within mine action comprise local and international companies and NGOs, government institutions and the armed forces. The coordination is rather loose.

Mine action resources have to be carefully managed to respond to national humanitarian and development priorities. Besides humanitarian imperatives mine action in Cambodia has a crucial role to play in supporting the socio-economic development and poverty reduction strategies set by the Royal Government (RGC).

However, little information about the socio-economic benefits of mine action has so far been collected. Furthermore there is a lack of specific tools to assist in the development of nation wide mine action priorities based on the amount of resources available and the development objectives of the RGC, and at the local level in the selection of minefields for clearance and in particular for conducting socio-economic cost-benefit analyses.

1.2 Objectives of the cost-benefit analysis

This cost-benefit analysis (CBA) of mine clearance operations in Cambodia was launched by CMAA in cooperation with UNDP. The socio-economic benefits of mine action will be assessed covering the period since the start of the programme in 1992, and a cost benefit analysis model developed for the use of the RGC and stakeholders involved in mine clearance.

The overall objective of the assignment is to:

- Provide a quantified assessment of mine action contribution to the socio-economic development of the country and the poverty reduction strategy/ Cambodian Millennium Development Goals (MDG) over the period 1993-2003.
- Devise a mechanism, based on a cost-benefit analysis, to assess the socio-economic and poverty reduction impact of future mine action operations.

The analysis of the “benefits” of mine clearance should include poverty reduction/ human development indicators in addition to the economic indicators, allowing for an assessment of the contribution of mine clearance to the achievement of the Cambodian MDG and the National Poverty Reduction Strategy.[2]

A tool will be devised for cost-benefit analysis of mine action sector activities, looking at the impact of clearance on other sectors, such as infrastructure development, access to natural resources, agriculture and tourism and the ultimate impact on overall development and poverty reduction. The socio-economic impact of mine clearance in religious and historical sites, especially Angkor should be duly analysed and quantified.

[2] UNDP (August 2004): Terms of Reference Cost-benefit analysis of mine clearance operations in Cambodia

1.3 Main approach and methodology

Conceptually, the socio-economic loss from accidents and contamination with landmines and Uxo can be divided in three broad categories:

(1) Loss of life, health, human production potential, and human welfare resulting from mine/Uxo accidents;

(2) Blocking access to mine-infested land and loss of associated production or consumption benefits from the areas concerned.

(3) Distortion of behaviour due to the existence of mines or Uxo, with consequent socio-economic losses resulting from longer travel distances or journeys and activities not undertaken due to greater distances and difficulties etc.

The costs connected with addressing the problem are related to the different aspects of the mine action programme, clearance operations, mine accidents during clearance operations, mine risk education and awareness, programme administration, planning etc.

Benefits minus costs or net benefits will evidently be a relevant socio-economic criterion, dividing by costs facilitates comparison of projects or clearance tasks of different sizes. The benefit-cost ratio or BCR (benefits minus cost divided by cost) is thus a widely applied criterion for ranking projects.

$$\text{Benefit-Cost Ratio (BCR):} \quad \frac{\text{Benefit} - \text{Cost}}{\text{Cost}}$$

The higher the BCR the more well-justified is the project. A negative ratio indicates that this clearance activity cannot be vindicated on the basis of the socio-economic benefits alone, as far as they are considered in the analysis. Different projects or clearance tasks can be ranked by their BCRs, and if resources are limited there will be a cut-off point for the BCR, below which the project/task concerned should not be implemented.

This needs not imply, however, that other than economic benefits and costs are irrelevant; frequently there will be additional considerations to take into account. Still in many cases the non-economic benefits may be related to the same factors that are basic for the calculation of economic benefits, in mine action this will typically be the number of mine/Uxo victims expected avoided in future years, and the size and types of area that can be reclaimed for useful purposes. In such cases the actual *priority* indicated may still be relevant even though the BCR might experience an upgrading in *magnitude* through the inclusion of non-economic benefits, so that a larger number of activities and tasks come out on the positive side. This could call for more resources to mine action, but nevertheless by withholding the main rank of priority.

The break-even point is when the BCR is 0. Then benefits will be equal to costs for the given discount rate, which is set at 10% in this study. A clearance task with a BCR of zero thus produces just enough benefits to meet its costs at a discount rate of 10%. Lowering the discount rate would increase the BCR of a project, by assigning more importance to future benefits.

The discount rate will depend among others on the general level of interest rates in the country net of the inflation rate, or how people in general value future benefits and losses. In case a person has the choice between 100 US$ today or 100 US$ in one year, it is expected that he will choose to have the money now, future benefits would be of less worth to him.

An individual who is precisely indifferent between having 100 US$ now and 110 US$ in one year, would recognize that he has a personal discount rate of 10%. Consequently he could apply this rate to discount future benefits or losses to find what they are worth for him from today's point of view, that is to say by calculating their Net Present Value. On similar grounds it can be assumed that society has its discount rate, which may be different from country to country and change over time.

A high discount rate (everything else being equal) means that few projects will come out with a satisfactory BCR. Nevertheless, it is generally wrong to think that projects in the developing world should be subject to low discount rates. Capital is scarce and competition for funds should be high among a large number of different uses.

The BCR permits reading directly the percent relation between the benefits and the costs. A BCR of 0.5 means that the benefits are 50% larger than the costs, with a BCR of 1 the benefits will be 100% larger than the costs (or 2 times larger) etc.

An alternative evaluation criterion is the Internal Rate of Return (IRR). The IRR constitutes a more intuitive measure of gain, by presenting a percentage rate of return on costs, much like the rate of interest on bank deposits. Generally the IRR is defined as the discount rate which makes the value of discounted future benefits equal to the costs. The IRR can be compared for example to the prevailing rate of interest net of inflation in a country.

A discount rate of 10% is being used in this study, and the minimum or break-even IRR should consequently be in the order of 10%. This will normally correspond to a BCR of zero as defined above.

The general time-horizon for benefits and costs is in this study set at 20 years. After that time benefits are considered too uncertain to be reckoned with. Benefits are discounted over 20 years, while all clearance costs normally are assumed to be incurred in the first year.

A main output from the analysis will be a ranking of different clearance tasks or activities in mine action according to their economic viability measured by their score on the BCR. A number of assumptions will be made to structure information into some more general cases, which are presumed to be typical for the areas where mine action is going on, the individual provinces etc. The validity of such assumptions should be checked, however, when data from the analysis is applied at specific clearance tasks.

The analysis will be based on available data and statistics mainly from recent years (2000-04), still unit costs and benefits can to some extent be used for the evaluation of mine action in earlier periods, with appropriate checking of assumptions. Regular updates will also be needed when the results from this study are applied at cost benefit analysis of future mine action activities.

After a shorter discussion (in chapter 2) of the most important social and development issues of the country, the extent of the mine and Uxo problem in Cambodia is described (in chapter 3). The goals, activities and organisation of the mine action programme are then related (chapter 4), with among others an assessment of the mine action programme's main targets and achievements (chapter 4.3).

The report then proceeds to explore the different elements entering into the cost benefit analysis of mine action. The first aspect is the humanitarian, the effect of mine action towards reducing the number of mine and Uxo casualties and the risk of accidents (chapter 5). The evaluation of the gains is here based on the productive contribution of a typical mine/Uxo victim over his/her lifetime. The resulting figures should in no case be conceived of as the value of a human life. Other factors which are more difficult to quantify could certainly play a

role when considering the humanitarian aspect of mine action. Still the approach is consistent with standard methodology for the evaluation of reduced accident risk in other sectors like road safety.

Another main component of a mine action programme is the clearance activity aimed at social and economic development, reopening access to productive areas, to infrastructure and other facilities and resources (chapter 6). These activities must also take into account the poverty reduction and social security aspects of development. The issues addressed here comprise clearance for agricultural purposes, mine and Uxo contamination of irrigation canals, roads, school premises, water supply, historic and cultural sites including temple areas, public buildings etc.

The cost side of the mine action activity will be considered (chapter 7), covering both the direct resource use for clearance and operations, and the more indirect expenses linked to planning and administration of the programme. In principle all input of resources to the programme should be comprised, including donations and gifts.

The benefit and the cost side will then be compared and balanced (chapter 8) in order to evaluate the economic viability of different tasks and cases, and to provide guidelines for prioritisation and recommendations on strategies in mine action. In this evaluation the Benefit-Cost Ratio (BCR) will be used extensively, and to some extent also the Internal Rate of Return.

The methodology developed will then be applied to evaluate the achievements of the Cambodian mine action programme in total (chapter 9). This evaluation will be conducted for a recent year (2003), as information is scarcer for the earlier periods.

The mine action programme’s contributions to achieve the objectives of the country’s poverty reduction strategy and to fulfil the Millennium Development Goals (MDG) will then be assessed (chapter 10). The main part of the report ends with a summary of important conclusions and recommendations (chapter 11).

On basis of the methodology and data presented the report proceeds with working out some specific tools for planning purposes that can be applied at future evaluation and prioritisation of clearance tasks in mine action (Annex 1). The objective is to devise a mechanism, based on cost-benefit methodology, to assess the socio-economic and poverty reduction impact of future mine action operations.

2. Social and economic context

2.1 The country and the people

The population of Cambodia is about 13.5 million, comprising for a large part rural fishermen, farmers, and artisans living in 2.2 million households, about 85% of the people live in rural areas. The majority of the people live in fairly permanent villages near the major bodies of water in the Tonle Sap Basin-Mekong Lowlands region. About 90 percent of the population is ethnic Khmer. The remaining 5-10 percent include Chinese-Khmer, Khmer Islam or Chams, ethnic hill-tribe people, known as the Khmer Loeu, and Vietnamese.

Agriculture is the most important sector, accounting for 33% of GDP, and employing about 70 percent of the labour force, but between 12% and 15% of these have no agricultural land. Many households are female headed, 19% in rural areas and 25% in the capital Phnom Penh. This is partly an effect of the wars, resulting in a surplus of women in certain age-groups.

Among the ASEAN countries Cambodia currently has the next highest population growth with 2.49%, being surpassed only by Laos. The fertility rate is high, and highest among poor people. At the same time the country has experienced a substantial fertility decline since the 1960s.[3]

Cambodia is not densely populated by South-East Asian standards. Still, much of the population is concentrated in the plains region, where pressure on land is very high. Access to adequate land is a widespread problem because significant areas are inaccessible, unsuited to cultivation, remain contaminated by landmines and Uxo, and because land ownership is unequal. As a result, over 14 per cent of rural households are landless. In addition, common pool resources such as forests and riverine areas are central to the livelihoods of the majority of rural Cambodians, while many such areas have been taken by powerful individuals and converted to logging concessions, plantations, or commercial development.

Because of its multiple regime changes and in particular the severe policies of the Khmer Rouge to create an egalitarian society, Cambodia's land problems are particularly acute. Hundreds of thousands of people have been displaced, entire families were wiped-out, and different groups obtained overlapping claims to the same land or its resources. Almost one-third of the households covered by the 1998 census reported that they had previously resided outside their place of enumeration. Many reasons for this migration were reported, with almost 14 per cent citing 'repatriation/return after displacement'. This latter group is particularly likely to be landless.

In an effort to address such problems, governments in the late 1980s-early 1990s issued a series of decrees allowing the issue of legal titles to those who needed land, often on a first-come, first-serve basis. Well-placed officials, senior military officers, and others in the elite were often first in line, but the majority of claims, from vulnerable groups such as women-headed households, indigenous peoples, returnees and displaced people, and demobilised soldiers, found themselves hostage to the shortcomings in the systems to administer these provisions. At least one million claimants did not receive land.

Efforts to address these post-clearance land use concerns led to the formation of the Land Use Planning Units (LUPU), which appear to have prevented the worst abuses. But the government's inability to deal with the broader land management issues led to the widespread eruption of protest demonstrations in the late 1990s. Local and international NGOs initiated a campaign for land reform, which led to a new land act in 2001. This new law also contains a

[3] Royal Government of Cambodia (2003): National Population Policy, page ii.

programme for distribution of unoccupied state land via social concessions and established provincial land dispute commissions.[4]

Labour force is growing rapidly (2.6%) with more than 200,000 new entrants into the labour market every year. About 35% of the workers are employed in more than one job. From 1998 to 2000 the average growth in agricultural employment was only 1.6%. Employment in the secondary and tertiary sectors was limited, while industrial growth was substantial with 43%. Still this benefited only about 8% of the population.[5]

About 46% of the labour force describes themselves as unpaid family workers. A significant percentage of women, 20 percent in Phnom Penh and 68 percent in rural areas, are unpaid family workers while the corresponding indicator for men is considerably lower (6% in Phnom Penh and 30% in rural areas).

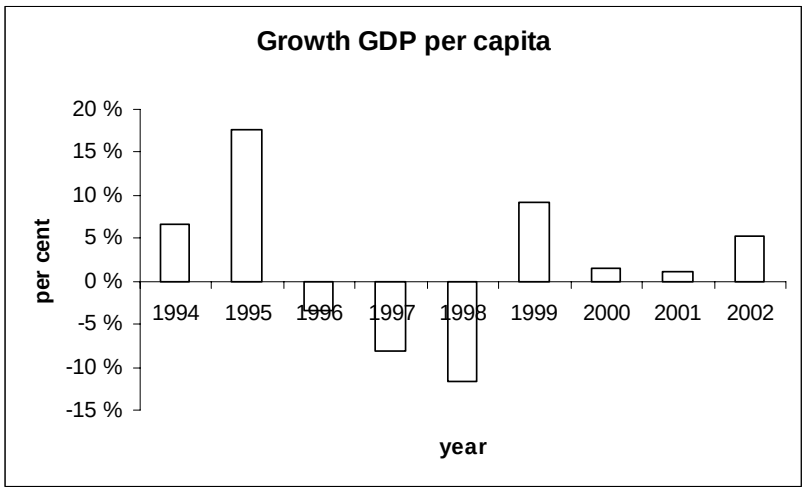
The production of rice for household consumption and domestic trade is the major economic output for most of the rural population. Households supplement rice production with other economic activities such as fishing, vegetable and fruit production, gathering of forest products, and off-farm employment.

Since 1993, the Cambodian government has implemented social, economic and legal reforms, and improved its support for private-sector led economic growth and trade development. One of the most significant changes has been the progress made in transitioning from a centrally-planned economy to a competitive market economy. Still the country suffers from few professional managers or skilled technicians, an undeveloped financial system, and few value-added products and services to promote international trade.[6]

Cambodia staged aggressive economic growth between 1993 and 1996, but ongoing civil strife, domestic political instability, the Asian financial crisis, and the failure of the government to implement necessary policy and legal reforms sharply slowed down economic activities and foreign investment. Per capita gross domestic product (GDP) was in 1998 estimated to US$ 252, compared to the 1995 level of US$ 321. The estimate for 2002 is US$ 296 per capita.

[4] Paterson and Vanna (2004): A Study of Capacity Development in Mine Action, Case Study of Cambodia (GICHD September 2004) page 59.
[5] Kingdom of Cambodia (20 Dec 2002): National Poverty Reduction Strategy 2003-2005, page iii.
[6] Source: WB/MIME (2003): Cambodia Renewable Energy Action Plan (1994-2000).

Figure 2.1: Growth rates in GDP per capita, Cambodia 1994-2002.



Source: National Institute of Statistics: Cambodia Year Book 2003.

Garments and footwear industries now contribute more than 90 percent of total exports and has been the main engine of growth over the last years, especially since the granting of Most Favoured Nation status and preferences by the USA in 1996-97. Still the further prospects for development of this sector are not evident, since competition from neighbouring countries has increased. The government's policy is therefore to diversify, in particular into the tourist industry, a trade which has experienced both growth and setbacks over the latest years.

Agricultural production, especially rice production, has responded well to extensive technical support by donors and incentives set by government agencies. During 1998/99 to 2001/02 Cambodia produced rice surpluses ranging from 30,000 to 350,000 tonnes. Still this did not eliminate the food shortage in some parts of the country.

Wood and rubber products, mostly in raw form, are exported primarily by regional traders. These products represent between three and four percent of Cambodia's export trade. Cross-border smuggling is a continuous and overwhelming problem.

Price inflation, based on the Cambodian reil, has been reduced from triple digits in late 1980s to less than one percent in 2000. Throughout most of Cambodia, the US dollar and the local currency co-exist in commercial transactions.

The central objective of the government's policy is to promote broad-based sustainable economic growth with equity, and with the private sector playing the leading role. Economic growth is considered central to the promotion of income opportunities to the poor.[7]

2.2 Poverty reduction

In Cambodia 36% of the population lives in absolute poverty, lacking the necessary minimum level of 2100 calories per person per day. The poverty aspect has many aspects: Lack of food, half of all children aged 0-5 years are either stunted or underweight, uncertainties about access to natural resources, lack of power, social exclusion, and lack of education are all dimensions of poverty.

[7] Kingdom of Cambodia (20 Dec 2002): National Poverty Reduction Strategy 2003-2005, page 42.

Only 27 out of 1000 school children manage to complete upper secondary school, and not more than 37% of Cambodians are functionally literate. In 1999 it was reported that 30% had never attended school.[8]

The country has the lowest health service utilisation in the world. Infant and maternal mortality rates have declined in recent years, but still remain among the highest in the region. Life expectancy at birth is 56 years. Most Cambodians lack access to safe water and sanitation, less than a third of the rural population has access to clean drinking water, while only about 10% are covered by environmental sanitation. Still the proportion of people living below the poverty line fell from 39% in 1993/94 to 36% in 1998, in rural areas the share fell from 43% to 40%.

Rural development is essential to alleviate national poverty, since the vast majority or 85% of Cambodians lives in rural areas. Development of the agricultural sector, which provides employment to 70% of the population and contributes about 45% of the GDP, will play a major role here. Better access for rural people to employment and basic infrastructure will also contribute to prevent excessive migration to the urban areas, which is a main cause of poverty there.

Livelihood systems are not secure for most rural communities, which comprise predominantly subsistence farmers. An estimated 60 % of the households there suffer from food deficits. Some villages have access to areas of good forest and are able to forage and hunt, or collect timber and non-timber forest products for immediate household consumption or sale. Others are able to supplement food crops with fish, but, in general, life is extremely difficult. Food stocks can begin running out for many families as early as four months after harvest.

Around 50% of the villages have 40-60 % of the households living below the official poverty line. Household savings are normally held in the form of assets such as livestock and land. These assets are often lost through forced sale due to economic shock such as serious health problems in families. Average household incomes vary widely, but the majority in the rural areas range from US$ 300 to 700 per annum. With an average family size of just over five in rural households, this equates to an annual per capita income of between US$ 60 and 140.

Through its National Poverty Reduction Strategy (NPRS) 2003-2005 the Government is committed to reducing poverty and inequality and to improve the quality of life for the population of the country. The NPRS considers landmines as one of the main obstacles preventing the poor from access to agricultural lands, creating vulnerability. Mine action is therefore a top priority in rehabilitation and development, in particular for achieving effective poverty reduction in rural areas.

The Poverty Reduction and Mine Actions Strategies state that mine action can contribute to poverty reduction by:

- Reducing the number of casualties which have negative economic consequences for affected families;
- Providing access for the worst-affected communities to essential services and infrastructure such as water resources, schools, hospitals and roads;
- Distributing safe land for settlement and agricultural purposes, contributing to the economic reintegration of landless populations in rural areas;
- Marking contaminated areas and educating and raising awareness as to the dangers of landmines and Uxo among the population of suspected areas;

[8] National Institute of Statistics: Cambodia Socio-Economic Survey 1999.

- Ensuring that the prioritisation and distribution of cleared land are monitored in a participatory, equitable and pro-poor manner at the provincial level;
- Providing assistance to the reintegration and rehabilitation of victims of land mines and UXO and their affected communities.[9]

2.3 The Ottawa Convention

The Kingdom of Cambodia is committed to the Ottawa Convention on the ban of landmines, the government became a signatory in December 1997. Cambodia is thus a state party to the Anti Personnel Mine Ban Treaty (APMBT) to enforce national legislation banning the production, use, transfer, and stockpiling of anti-personnel mines.

The member states are committed to take steps consistent with the Convention's core humanitarian aims: to clear mined areas, assist victims, and universalise the ban on anti-personnel mines. Each year the government is obliged to report on the implementation of the treaty in Cambodia to the Meeting of the States Parties to the APMBT.

The Ottawa Convention stipulates among others the following:

"Each State Party undertakes to destroy or ensure the destruction of all anti-personnel mines in areas under its jurisdiction or control, as soon as possible but not later than ten years after the entry into force of this Convention for that State Party" (Article 5, paragraph 1).

This is a commitment with serious consequences for Cambodia given the extensive amount of suspected mined areas registered there. Still "if a State Party believes that it will be unable to destroy or ensure the destruction of all anti-personnel mines referred to in paragraph 1 within that time period, it may submit a request to a Meeting of the States Parties or a Review Conference for an extension of the deadline for completing the destruction of such anti-personnel mines, for a period of up to ten years" (Article 5, paragraph 5).

2.4 The Millennium Development Goals

The Millennium Declaration was adopted in September 2000 by all 180 member states of the UN. World leaders here agreed to a set of time-bound and measurable goals for combating extreme poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women, called the Millennium Development Goals (MDG). The Government of Cambodia has signed this declaration, because it is consistent with its long term commitment to improve living conditions and reduce poverty.[10]

Recognising the large negative impact of mines on the livelihood of people living in rural areas, mine action is considered one of the top priorities for the country's rehabilitation and development. The government is further strongly committed to implement the Ottawa Convention. De-mining, Uxo and Victims Assistance have therefore been introduced as Goal number 9 in the MDG Report 2003.

In compliance with its obligations towards the Ottawa convention the MDG 9 sets a target to move towards zero impact from landmines and Uxo in 2012. The annual number of civilian casualties will then have to be reduced to 0, and all suspected areas cleared. It is admitted,

[9] National Poverty Reduction Strategy 2003-2005, chapter 4.5.5 and CMAA: National Mine Action Strategy 2004, chapter 4.2.2.
[10] Kingdom of Cambodia (2003): Cambodia Millennium Development Goals Report 2003, page 9.

however, that this may be difficult to achieve. Other actions consist of developing a victim assistance framework.[11]

Still, mine action, and in particular area clearance may also have impact for other MDGs:

- Clearance of areas that can be reclaimed for agricultural production can have strong impacts for MDG 1- Overall target 2, concerned with reducing the proportion of people suffering from hunger.
- De-mining school premises can contribute to fulfilling MDG 2- Overall target 3, aiming at improving the education system so that more children can be able to complete school.
- Mine clearance is also frequently required to provide access to rural health stations, which are much needed in the fight against the spread of diseases like HIV/AIDS and malaria (MDG 6) and to reduce child mortality (MDG 4) and maternal mortality (MGD 5).
- Clearance of water supply systems and rural wells could have a direct impact on MDG 7- Overall target 14, addressing the problem of improved access to safe drinking water.
- Clearance of areas for resettlement, with a transparent and equitable system for redistribution of the land, will in general also be important for MDG 7- Overall target 16, to improve the access to land security.

More specific measures for the achievements of these goals have been worked out in chapter 10 of this report.

[11] Kingdom of Cambodia (2003): Cambodia Millennium Development Goals Report 2003, page 73.

3. Mines and Uxo in Cambodia

3.1 Contamination

The later 35 years of conflict has left Cambodia one of the world's most heavily mine- and Uxo-contaminated nations. The Level One Survey (L1S) measuring the impact of mines/UXO in the entire country was completed in April 2002. Here it was indicated 3,037 suspected areas, amounting to 4,466 km² that could be contaminated by mines or Uxo. This represents 2.5 % of the country's surface area.

According to the L1S about 1,640 villages, i.e. approximately 12 % of all, have to cope with high contamination by landmines and Uxo, and more than 5,500 have Uxo scattered on their land. About 60% of the mine-suspected areas are concentrated in the five provinces of Battambang, Banteay Meanchey, Odtar Meanchey, Preah Vihear and Pailin in the north-western and northern regions of the country. More than 11,000 explosive ordnance disposal tasks were recorded.

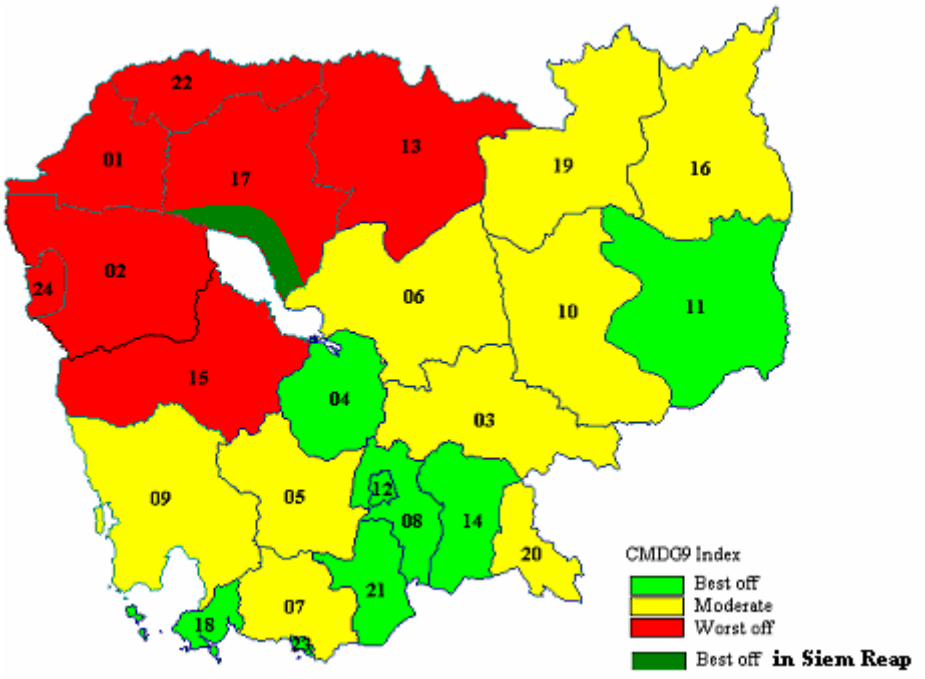


Figure 3.1: Mine and Uxo contamination in Cambodia. Source CMAA[12]

The mine/Uxo contamination in the country as registered in L1S can be broken down by province, with high level of contamination in 7 provinces, moderate level in 9, and low level in 8 provinces.

However, it should be noted that due to the nature of technical requirements and methodology, the L1S could not have measured the precise size of the affected areas or the scope of the contamination. There are indications both that L1S may have exaggerated the contamination in some places and that there may be contaminated areas also outside the L1S areas. A study of minefields cleared by the operators in 2003 shows that only 64% of them

[12] Source: CMAA (2004): Mine Action Achievements of the Kingdom of Cambodia 1992-2003, chapter 1.2.3.

were included in one of the suspected mined areas listed in the L1S, 36% of cleared areas were thus outside the L1S.[13]

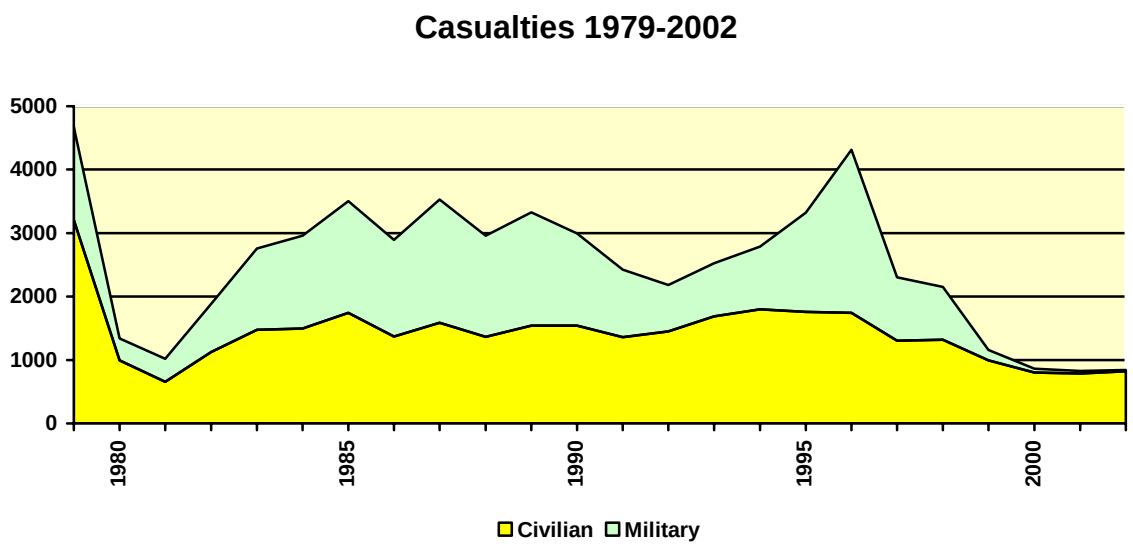
On the other hand, huge suspected surface areas do not need a very urgent clearance; since they are located in very remote parts of the country, without population and no fertile land, as it is the case in the north of the Siem Reap province. So the L1S data has to be updated regularly and checked by national competent authorities and demining operators, in order to provide valuable information.

In the absence of accurate information on the size of the mine-contaminated area, CMAA has used a proportion amounting to 10%[14] of the L1S estimates as a planning figure to determine the scope of contamination in the country, which means that the current contaminated area could comprise about 425 km^2 in total.[15] Contaminated areas identified by the operating agencies (HALO and CMAC) and classified as of high priority, amount to about 260 km^2 in 2004.[16]

3.2 Human loss

Between January 1979 and December 2003, Cambodia suffered a total of over 60,000 mine/Uxo casualties. Despite the relatively large volume of de-mining operations, the level of contamination and the number of civilian accidents continue to be among the highest in the world, indicating the extraordinarily high level of contamination in the country as a result of decades of conflict. In the year 2003 there were 772 and in 2004 a total of 891 people reported as direct victims of accidents by mines or Uxo.

Figure 3.2: Mine and Uxo casualties in Cambodia 1979-2002



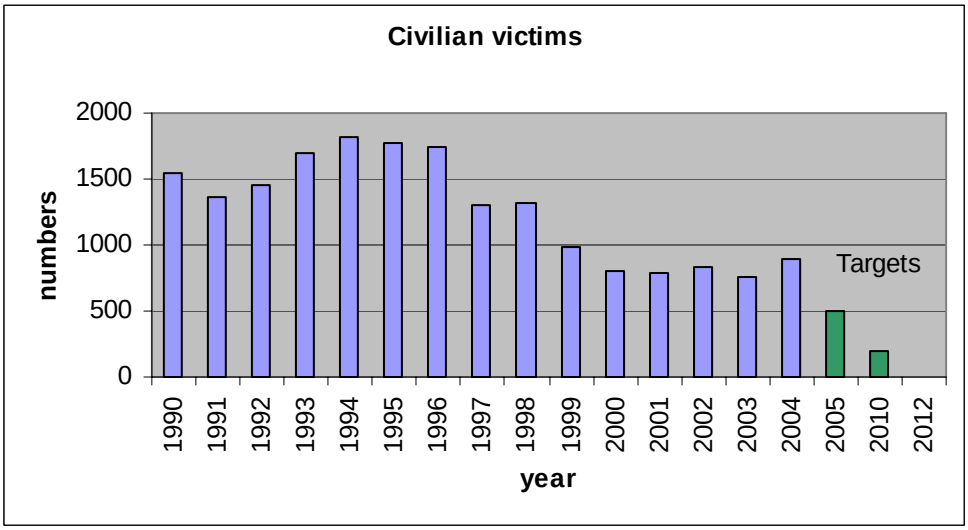
Source: CMVIS: National Census of the victims & survivors of landmines and unexploded ordnance in Cambodia.

[13] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 1.3.
[14] This figure will be updated as more accurate information of actual contamination becomes available.
[15] CMAA (2004): Five Year Mine Action Plan 2004-2008, chapter 3.1.
[16] Source: National Mine Action Database

Of the mine/UXO casualties recorded for the years 1979-2003, about 30% died and 70% have suffered non-fatal injuries, i.e. about 40,000. Many of these victims have been maimed and are now disabled, having suffered grave injuries as amputation, burns, blindness or paralysis.

In the earlier years records were less complete and accurate, but civilian casualties peaked at 1700-1800 per year from 1993-96, falling to about 1300 per year until the end of hostilities in late 1998, then dropping again to about 800 per year, with 830 in 2002 and 772 in 2003, while the year 2004 experienced a significant leap to 891.

Figure 3.3: Civilian casualties annually (military personnel excluded)



Source: CMVIS[17] and CMAA[18]

Still, from 2000 on the number of accidents caused by mines decreased steadily from 443 to 341 in 2004. Unfortunately this was accompanied by an increasing trend of Uxo casualties, from 389 in the year 2000 to 550 in 2004, with a leap of 140 in 2004 alone, so that Uxo casualties now constitute well over 50% of the victims. The policy targets in Figure 3.3 of 500 victims in 2005, 250 in 2010 and 0 in 2012 are reflected in the Cambodian National Mine Action Strategy and the Millennium Development Goals, and are designed to comply with the Ottawa Convention.

[17] CMVIS (2003): National Census
[18] Source for Targets 2005-12: CMAA (2004): National Mine Action Strategy 2004, chapter 3.1 and Cambodia Millennium Development Goals November 2003) table 2.9.1.

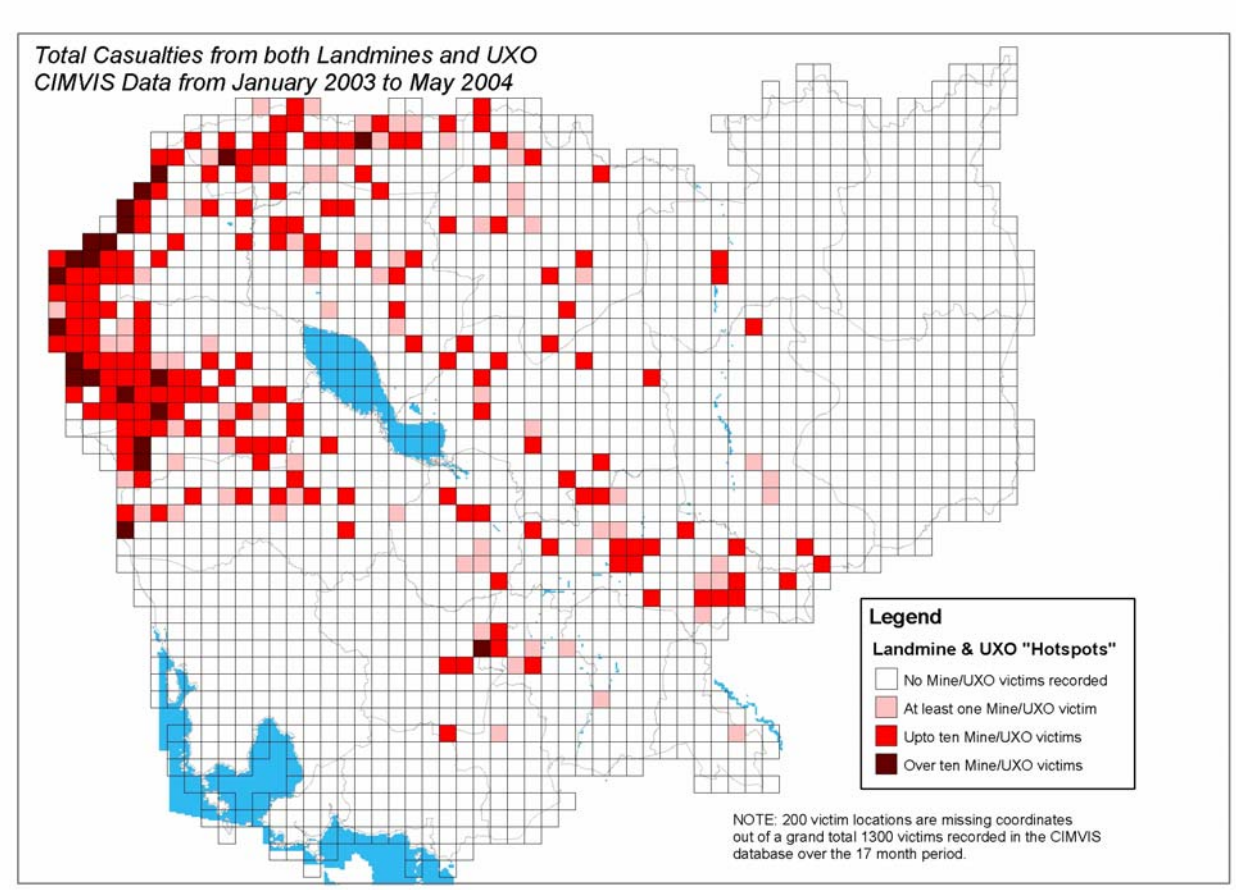


Figure 3.4: Mine and Uxo casualties January 2003 to May 2004 (source CMAA).

The geographical distribution of mine and Uxo victims in Cambodia (Figure 3.4) shows a marked concentration on the regions to the north-west, on the border with Thailand. There are also incidents elsewhere, in the central parts of the country and towards the border with Vietnam in the south-east. A remarkable feature is the few incidents reported from the east and north-east, the regions bordering Laos and Vietnam. These parts of the country were heavily bombarded during the Vietnam War and must contain large amounts of mines and Uxos. An explanation could be that the sparse population of these regions generate few accidents, but there is also a possibility of under-reporting because of lack of inspection and communication. The deficient road system discourages people and officials from travelling there.

All provinces and municipalities have been concerned with mine accidents in 2002 or 2003, except Phnom Penh and Kep, i.e. 22 out of 24, among these eight had less than one mine accident a month.[19] In 2004 the Battambang province experienced an average of about 10 mine casualties per month, Banteay Meanchey had 8 and Pailin 4.

[19] Battambang province suffered more than 12 MA per month, or 3 MA per week, in 2002. In 2003, 6 MA with UXO injured 26 people in Kandal province.

Table 3.1: Victims' activity at the time of mine and Uxo incident (year 2002-2003)

	Mine	Uxo
Tampering with mine/Uxo	5 %	59 %
Bystander	3 %	18 %
Travelling	29 %	1 %
Farming	21 %	7 %
Collecting wood	21 %	1 %
Collecting food	7 %	1 %
Clearing new land	5 %	3 %
Burning	1 %	2 %
Herding	2 %	2 %
Demining	2 %	0 %
Military activity	2 %	0 %
Construction	1 %	0 %
Fishing	1 %	1 %
Playing	0 %	1 %
Other	2 %	4 %
Total	100 %	100 %

Source: CMVIS National Census

Mine and Uxo accidents follow separate patterns: In 2002/2003 about 70% of the mine victims were exposed to accidents while travelling, doing farm work or collecting wood, whereas 59% of the Uxo victims were tampering with the Uxo, with another 18% standing by as lookers on.

Uxo incidents tend to result in more casualties than mine accidents. Statistics from 2002 show that 10 mine incidents caused 13 casualties on the average, while as much as 18 persons could be injured in 10 Uxo incidents. In 2003 these rates had increased to 15 persons at 10 mine incidents and 20 persons at 10 Uxo incidents.

Table 3.2: Age and gender of mine and Uxo victims (year 2002-2003)

	Mine	Uxo	Total
Men	80 %	42 %	59 %
Boys	11 %	43 %	29 %
Women	7 %	5 %	6 %
Girls	2 %	10 %	6 %
Total	100 %	100 %	100 %

Source: CMVIS National Census

Males are much more frequently exposed to mine and Uxo accidents then females. Men and boys constituted 88% of the total number of casualties in 2002-2003. At mine accidents 80% of the victims are men 11% boys. Uxo incidents, however, involve just as many boys (43%) as men (42%), while girls fall victims (10%) presumably because standing among the lookers on.

Increasing numbers of Uxo victims are now found scattered in almost all provinces. Investigations carried out by the Cambodian Red Cross (CRC) and Handicap International of Belgium (HI), show that insufficient information about the danger of explosive devices has been disseminated in the villages where accidents happened. Individuals tampering with Uxos

and lookers on comprise almost half of the casualties.[20] If it had not been for that tampering of mine/Uxo and on-looking people around, about 330 casualties would have been avoided in 2003 which is almost half the casualties that year.[21]

In Cambodia there is regularly a trend towards high numbers of mine and Uxo casualties in the beginning of the year, coinciding with the dry season when villagers are roaming the forests in search of food and fuelwood. Most provinces experience lower levels of accidents in the wet season from May to November.

The death rate among mine and Uxo victims is now (2002-2003) about 16% and the same for both categories of accidents. Additionally 23% of the victims have to undergo amputations while 61% are classified as injured.

Table 3.3: Place of accident

	Mine	Uxo
In forest	50 %	14 %
In village	4 %	41 %
Rice field	10 %	16 %
Near river	6 %	12 %
On path	12 %	3 %
Grazing field	4 %	6 %
On mountain/hill	5 %	1 %
Near military position	3 %	3 %
On road	3 %	0 %
Other	3 %	3 %
	100 %	100 %

Source: CMVIS National Census

Forests seem to be dangerous places as 50% of the mine casualties report to have fallen victims there. As regards the Uxo casualties, the largest part of the accidents takes place in the village. However, a concept of the real threat represented by different locations or types of areas could only be established if the number of accidents was related to the total extent of the mined/ Uxo infested areas of these categories.

3.3 Blocking infrastructure

In Cambodia poor households are forced to take risks with mines/Uxo because of economic necessity. Families could face starvation if they were not willing to take risks, farming land that may be contaminated or gathering forest produce. About 2,300 villages have reported restricted access to neighboring communities, while significant numbers of villages reported restricted access to pagodas (1,487 villages), markets (1,334), health centers (1,312), and schools (affecting about 44,000 students).

[20] CMAA (2004): Mine Action Achievements of the Kingdom of Cambodia 1992-2003, Executive Summary.
[21] CMAA (2004): Mine Action Achievements of the Kingdom of Cambodia 1992-2003, chapter 1.3.3.3.

The mines/Uxos had severe impact on the villagers[22]:

- Not enough agricultural land 22%
- High number of human casualties 19%
- Gathering activities affected 18%
- Not enough housing land 15%,
- Experienced loss of livestock 14%
- Difficult water access 12%.

The most common constraints reported were as follows[23]:

Restricted access to:	**Number of suspected areas**	**Number of families affected**
Agricultural land	2,077	102,778
Forests	2,000	172,878
Pasture land	1,781	105,707
Water sources	1,184	84,588

[22] Level One Survey, referred in CMAC: Annual Report 2003, page 2.
[23] Source: CMAA Level One Survey (L1S) referred in Paterson and Vanna (2004): A Study of Capacity Development in Mine Action, Case Study of Cambodia (GICHD September 2004) page 20.

4. The mine action programme

4.1 Visions and planning strategies

Mine action is considered by the RGC as one of the top priorities for rehabilitation and development of the country. It has been fully integrated among Cambodia's Millennium Development Goals and in its Poverty Reduction Strategy (NPRS).

The long-term mission for mine action in Cambodia is, according to the National Mine Action Strategy 2004 (NMAS), to eliminate as soon as possible the risk of death or injury to individuals living in mined areas, to significantly reduce the negative socio-economic impact of landmines/ UXO on the population while achieving humanitarian and national development goals, in order to ensure the prioritisation for poor people and the rehabilitation and welfare of landmine victims in society and to comply with the international conventions on mine action.[24]

For the foreseeable future, the primary focus of the mine action sector in Cambodia will most likely remain humanitarian in nature e.g. clearing mines and UXO to reduce the risks to human life. The humanitarian imperative has been and will stay the raison d'être of mine action.[25]

The National Mine Action Strategy comprises the following visions[26]:

- The medium-term vision is to move towards zero impact from land mines and UXO by 2012, in order to enhance security, alleviate poverty and to sustain development, as ensured by clearing all severe/high risk suspected mined areas and developing intensive mine risk education for the medium and low suspected areas with mines and UXO.
- The long-term vision is to have a Cambodia free from the negative humanitarian and socio-economic impacts of landmines/ UXO by 2020 by sustaining a national capability to address the problem in non-cleared and remote areas from 2012.

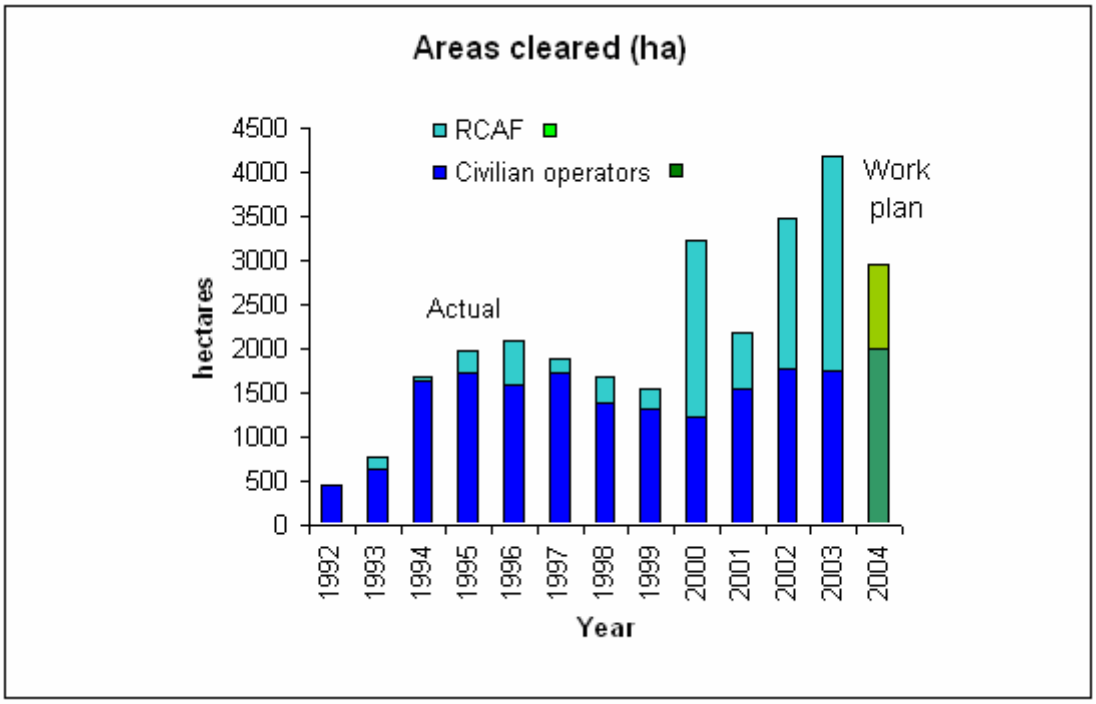
The strategy is to clear the worst-affected areas to reduce as soon as possible to a negligible and nationally acceptable level, the risk of death or injury to individuals living in landmine/ Uxo-affected parts of the country, where access is denied to critical life-dependent resources, such as water and food crops for which there are no viable alternatives. This reducing of the impact of mines/Uxo will be carried out as quickly as possible by increasing outputs coupled with improved targeting of most affected areas.[27]

4.2 Clearance activities

Mine action activities in Cambodia began during the United Nations Transitional Authority of Cambodia (UNTAC) era in 1992 with international technical and financial support. From 1992 to December 2003 the various mine clearance operators had cleared a total area of 252 km^2. Figure 4.1 includes the areas reported from all the certified mine clearance agencies.[28]

[24] CMAA: National Mine Action Strategy 2004, chapter 5.
[25] CMAA: National Mine Action Strategy 2004, chapter 4.2.
[26] CMAA: National Mine Action Strategy 2004, chapter 2.
[27] CMAA: National Mine Action Strategy 2004, chapter 4.2.1.
[28] Actually CMAC, HALO Trust, MAG, RCAF, but other agencies were involved in earlier years.

Figure 4.1: Areas cleared (ha) 1992-2003 and the mine action work plan for 2004.



Source: CMAA[29]

Currently, four main operators are involved in mine and UXO clearance: CMAC the national governmental operator, the international agencies HALO Trust and MAG, which constitute the 3 civilian operators, and the Royal Cambodian Armed Forces (RCAF)/Engineering Command Force.

Parts of the areas reported by the RCAF are presumed to be combined survey and clearance of roads in support of rehabilitation works. Far higher rates of productivity are normal for such combined survey/clearance tasks, as most of the area is not in fact contaminated. RCAF reported exceptional clearance activity in the years 2000, 2002 and 2003.

An important task of mine clearance was carried out in the south of the province of Siem Reap from 1992 on, to give access to the main historical and religious site in the Kingdom of Cambodia, the Angkor area.

In addition to the reduction of the human loss, a main goal for the mine action programme in Cambodia is to prioritise mined land for clearance according to socio-economic needs at the local level. Safe land for settlement and agricultural purposes will be distributed, contributing to the economic reintegration of landless populations in rural areas, and communities will be provided with access to essential services and infrastructure such as water resources, schools, hospitals and roads.

The mine action strategy thus distinguishes between clearance of severely mined villages with high levels of casualties, and providing access to productive land improving the living conditions for poor people, de-mining of specific areas such as historical sites to promote development of the tourist industry, or clearing infrastructure such as roads allowing communication with other parts of the country. The programme aims at putting in place a community based, transparent, participative and decentralized process to identify those villages, families and persons that will be entitled to receive cleared lands.

[29] CMAA (2004): Mine Action Achievements of the Kingdom of Cambodia 1992-2003, chapter 2.2.1.

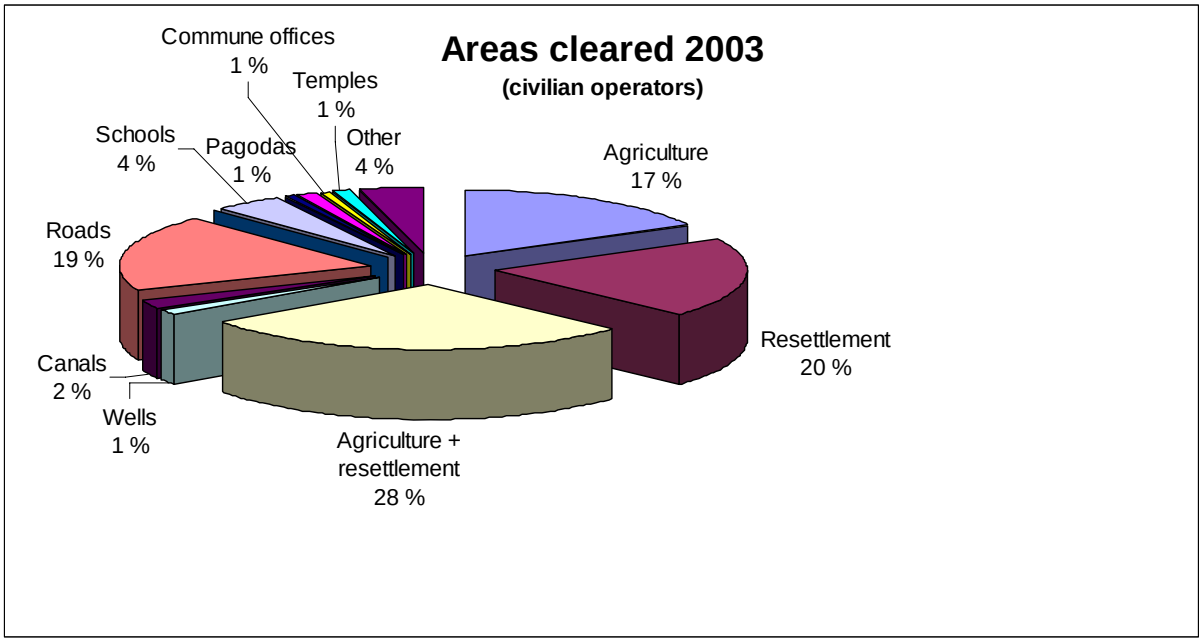


Figure 4.2: Areas cleared by civilian agencies in 2003.

Figure 4.2 provides a distribution of the areas cleared in 2003 by types of land. The large majority, 65% of the clearance, is connected with agriculture and resettlement schemes of displaced people. Roads make up a significant proportion (19% and 313 km) and the remaining areas are clearance tasks connected to specific locations, public buildings, water supply, irrigation canals, temple areas etc.[30]

The figures include only the civilian operators (CMAC, HALO, MAG) and their clearance of 16.5 km^2. Distribution on types of areas has not been obtained from RCAF, which activities comprised 24.4 km^2 in 2003. The total area cleared in 2003 was thus 40.9 km^2, which should be the largest annual achievement ever in mine action in Cambodia.

The National Work Plan for 2004 comprises (without RCAF) clearance of the following areas[31]:

- Agriculture: 550 ha
- Resettlement: 426 ha
- Agriculture and resettlement: 193 ha.
- Casualty reduction: 105 ha.
- Wells, ponds: 14 tasks.
- Canals: 11 tasks.
- Roads: 91 tasks, 29 km.
- Bridges: 1 task.
- Schools: 41 tasks.
- Health centres: 5 tasks.
- Commune offices: 6 tasks.
- Other: 19 tasks.

This amounts to an area of 19.9 km^2 and with a contribution from RCAF of 9.7 km^2, the area planned for clearance in 2004 comprises 29.6 km^2 in total.[32]

[30] Areas related to these clearance tasks have been estimated since the statistics mainly gives the number of tasks.
[31] CMAA (2004): Mine Clearance Analysis and Guidance 2004, chapter 2.2.3.

4.3 Assessment of targets and achievements

Concerning casualties, the RGC is firmly committed towards zero impact from landmines and Uxo by 2012 as per pledges in the Ottawa Convention. A target of less than 280 civilian casualties has consequently to be reached in 2008 in order to be near zero in 2012. Based on a straightforward linear projection, however, the target for the number of casualties can hardly be met as foreseen. Indeed, despite of a reassuring decrease in 2003, an unexpected increase of civilian casualties occurred in 2004.[33]

On mine clearance, the RGC is committed to ensure that at least 65% of the suspected areas will be cleared by the end of 2008 in order to have 100% of the suspected mined areas cleared by 2015. This is based, of course, on an assumption that the suspected, dangerous areas can be properly identified and duly targeted. The clearance targets are now based on the CMAA estimate that only 10% of the L1S areas are contaminated and have to be cleared. After this reduction, the objective of mine clearance pertains to about 425 km^2.

To reach this target an average of at least 30 km^2 must be cleared every year as of 2003. This could be met given the actual capacity of the 4 participating clearance agencies, the problem is, however, that a large part of their clearance activity, as much as 36% in 2003, is conducted outside the designated (L1S) areas. It can actually be claimed that an important percentage of the clearance achieved should not be taken into account in the calculations since it has not been implemented in L1S's suspected mined area.[34]

In 2003 about 36% of cleared areas were outside the L1S.[35] At the same time it is clear that L1S also failed to take into account important contaminated area. One explanation of the lack of coverage is that parts of some provinces were not populated at the time when the L1S team undertook its survey activities (year 2000-2002), and large scale population movements have been going on since.

A slight increase in the annual clearance rate has been achieved over the last years, but despite this positive trend and even if the assumption of having only 10% of the L1S area contaminated is right, it is not sure that the target will be reached in 2015. The situation could demand an increase in the current clearance capacity.[36]

Realistically it is anticipated that mine action operations will need to continue at a persistent and even reinforced level at least until 2020. Sustainable efforts will have to be maintained in clearance and mine risk education, especially for Uxo. Even beyond this period a reduced capability will probably be needed, with smaller and mobile de-mining teams to deal with specific clearance tasks and numerous Uxo, possibly for as long as a further 50 years.[37]

In order to fulfil the goals immediate priority should be given to those areas which produce largest effect towards reducing the number of casualties. This will of course depend on the application of efficient planning tools including identification and prioritization mechanisms at the local level, by CMAA, the operators and the donors. CMAA has applied a set of criteria to measure the socio economic impact that mines/Uxo have on communities, ranking villages based on their impact score[38] and grouping them into categories. This exercise has been

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[32] CMAA (2004): Mine Clearance Analysis and Guidance 2004, chapter 2.1.1.
[33] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 4.1.2.
[34] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 4.1.2.
[35] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 1.3.
[36] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 4.1.
[37] CMAA: National Mine Action Strategy 2004, chapter 1.2.
[38] Score is based on three major impact factors; the number of recent victims, the facilities and livelihood areas to which mines block access, and the type of contamination.

conducted on the suspected 425 km^2 to distribute the area on the impact categories "severe, high, medium and low" and geographically on provinces.[39]

The Five Year Plan assumes that priority is given to clear severe and high impact areas before medium and low in order to alleviate the casualty rate.[40] A total of about 300 km^2 are thus presumably causing the main part of the above mentioned accidents problems and will consequently be attended to first.

The problem with this reduced area is, however, the same as with the total L1S area: It cannot be claimed to cover the total suspected area in the country. In total it may not exaggerate the extent of the priority contaminated area, but it is still a fact that considerable amounts of clearance activities are going on at the outside. Data from the operators (HALO and CMAC) indicate high-priority mined areas amounting to about 260 km^2 as of 2004,[41] and comparison between the CMAA priority area and the operators' data reveals a rather different distribution on provinces as shown in table 4.1.

	CMAA severe and high categories	Operators data	CBA estimate
Battambang	96.2	46.0	72.2
Pursat	51.5	2.7	38.6
Siem Reap	41.9	51.1	38.3
Otdar Meanchey	28.1	41.6	31.2
Banteay Meanchey	27.8	75.9	56.9
Pailin	18.2	2.3	13.7
Kampong Thom	4.3	3.1	3.2
Kampong Cham	6.9	20.1	15.0
Kampong Speu	1.7	2.6	1.9
Kracheh	2.2	0.0	1.7
Preah Vihear	1.1	18.5	13.9
Others	22.8	0.0	17.1
Total	302.8	263.8	303.7

Table 4.1: Priority contaminated area in km^2, information from CMAA and the operators.

The operators have identified considerably more contaminated areas in provinces like Preah Vihear, Kampong Cham, Banteay Meanchey, Odtar Meanchey and Siem Reap than the L1S based CMAA estimate on severe and high impact areas. Provinces like Battambang, Pursat and Pailin have on the other hand much less priority mined area in the data from the operators compared to the CMAA estimates.

In a recent report (Griffin and Keeley 2004) the mine/Uxo contamination in Cambodia has been assessed based on information of the L1S, US bombing records, land cover mapping, areas already cleared etc. Suspected areas are consecutively reduced to a total of about 450 km^2, indicated as the total likely area contaminated agricultural ground with economic value. It is also stated that further reductions may be possible.[42]

It is strongly recommended to revise the L1S estimate of contaminated area. The mapping tools already at disposal with CMAA combined with the scheduled reinforcement of the planning capacity at the local level (see chapter 4.4.2) should improve the possibility of conducting this appraisal. Area revisions should also to a greater extent than the L1S take into

[39] CMAA (2004): Five Year Mine Action Plan 2004-2008, chapter 3.1.1
[40] CMAA (2004): Five Year Mine Action Plan 2004-2008, chapter 3.1.3.
[41] Source: National Mine Action Database
[42] Griffin and Keeley (December 2004): Joint Evaluation of Mine Action in Cambodia, page 10 and Annex 2.1.

account information also from the operators, while such data may not always give the complete picture.

Clearance of mine and Uxo contaminated areas constitutes together with mine risk education the principal action parameters of a mine action programme. As an important input to this cost benefit analysis there will be a need for some estimate of the total priority area to be cleared in the country. The cost benefit analysis should also to the largest possible extent be conducted at a disaggregated level, targeting the provinces in the first instant.

Based on the afore mentioned factors the CBA proposes a preliminary estimate of the high priority contaminated land, consisting of the CMAA/L1S severe and high priority categories for the provinces where these constitute the largest area and the data from the operators for the provinces where these are found to be the most extensive. Finally these estimates are reduced with 25% so as to comply with the CMAA/L1S appraisal that there are about 300 km^2 of severe and high priority contaminated areas in the country. The distribution of this area on provinces will, however, be different in the CBA estimate both from CMAA/L1S and the operators' data (table 4.1).

The CBA estimate thus attempts to take into account the fact that the L1S estimate could fail to target contaminated areas at some locations, while the operators also may fall short of recognising areas, particularly in regions where they have no activity.

In the further analysis (see chapter 5) this area will be considered as a principal source of the mine and (partially) the Uxo accidents in the country. It must, however, be realised that this estimate is subject to shortcomings, and better ones could easily be plugged into the analysis as soon as they become available.

Province		2000	2001	2002	2003	2004	Total clearance 1992-2003
Battambang	Clearance (ha)	442	393	353	310		3277
	Mine victims	180	148	105	109	129	
	Uxo victims	78	58	81	60	122	
Pursat	Clearance (ha)	1	7	114	150		312
	Mine victims	15	13	8	17	15	
	Uxo victims	25	16	12	15	24	
Siem Reap	Clearance (ha)	139	189	182	107		1813
	Mine victims	10	13	6	6	3	
	Uxo victims	32	21	43	49	16	
Otdar Meanchey	Clearance (ha)	210	375	398	224		1229
	Mine victims	41	37	37	54	27	
	Uxo victims	25	31	41	43	48	
Banteay Meanchey	Clearance (ha)	419	354	320	231		3831
	Mine victims	110	105	110	87	98	
	Uxo victims	12	28	25	33	36	
Pailin	Clearance (ha)	4	73	150	70		297
	Mine victims	47	40	54	55	50	
	Uxo victims	16	17	8	24	48	
Kampong Cham	Clearance (ha)	25	1	7	5		419
	Mine victims	0	12	8	10	4	
	Uxo victims	29	37	70	28	72	
Preah Vihear	Clearance (ha)	53	23	75	75		225
	Mine victims	15	17	25	10	10	
	Uxo victims	52	35	40	31	24	
Total	Mine victims	443	434	366	362	341	
	Uxo victims	389	390	475	410	550	
Total victims		832	824	841	772	891	
Total clearance (ha)		3225	2188	3483	4177	2966[43]	25174

Table 4.2: Impact on accidents rates from the clearance of contaminated areas.

Clearance of dangerously contaminated land should have an apparent impact on the accident rate in the neighbouring areas which were exposed to the risk. Even though many random factors may influence the accident numbers for an individual year, the effect should be visible at least when looking at statistics for several following years or through the analysis of a number of similar cases at different locations and/or periods.

I table 4.2 the clearance activity at the provincial level for the years 2000 to 2003 and during the whole period 1992-2003 has been related to the recorded casualty rates in the province for mine and Uxo incidents separately.

Even in the provinces with the highest number of casualties and also the largest amount of clearance activity, Battambang and Banteay Meanchey, it is difficult to find a clear decreasing trend in the mine-accident frequency. Battambang definitely experienced a drop in 2000-02, but the rate is on the increase again especially in 2004.

In Pailin there was no clearance at all recorded before year 2000, but the concentrated effort over the last 3 years has not resulted in any significant drop in the mine casualty rate. In Preah

[43] Planned

Vihear the clearing likewise started in the year 2000 while the accident rate is rather fluctuating over the later years.

Siem Reap shows more of the pattern one could expect in response to substantial efforts of clearance activities, but the accident figures are rather small here over the whole period considered.

For the Uxo accident it is even more difficult to disentangle effects from clearance. In many provinces it is heavily on the rise despite the clearance activity.

The first objection to the analysis could be to point out the difficulty in telling from the figures in table 4.2 what the accident rates would have been *without* any ongoing clearance activity. They could presumably have been much higher, so that the clearance efforts at least contributed to mitigate the even more disastrous potential impacts from the contaminated areas. In some places this might be an explanation, and a more thorough analysis would be needed to identify where and why this is the case. A consequence would be that substantially larger clearance efforts are needed in order to reach the agreed on goals for reduction in casualty rates.

It is by now generally admitted, however, that while the clearance of minefields can contribute to reduce the number of mine accidents, other measures like mine risk education will have to be strengthened in order to reduce the number of Uxo casualties.

Nonetheless, it is disconcerting to be able to trace so few clear impacts all over, and the problem could be that the analysis is conducted on a too high level, district or commune could be more appropriate. Other time periods could also be selected, for example 1996-2000, which demonstrates the largest decline in accidents rates in recent years from about 1750 to 800 (figure 3.3). This was apparently also achieved with smaller efforts than have been deployed later on. The clearance rate of about 20 km^2 a year in 1996 was declining to about 16 km^2 in 1999, compared with areas between 20 km^2 and up to over 40 km^2 in recent years. The variations are smaller, however, when looking at the output for the civilian operators only (figure 4.1). Such studies could be launched as more detailed and better data becomes available.[44]

In any case the mine action programme in Cambodia is not an exception here. Concrete studies demonstrating the relation between mine action activities and risk reduction are indeed very scarce. The GICHD/UNDP Study of Socio-Economic Approaches to Mine Action states that "in the case of risk reduction, the study team did not come across a single report that adequately documents how much the accident rate has fallen due to mine action. While it is clear that the numbers of landmine and Uxo accidents have fallen in many countries having mine action programmes, it remains unclear how much of the decline is the result of mine action."[45]

It is furthermore stated that decline in accident rates may be the outcome of a variety of factors:

- people learning to avoid contaminated areas,
- "spontaneous" declines in risky behaviour,
- reflecting the end of large population movements caused by conflict and remigration,

[44] The clearance data on provinces used in table 4.2 are not complete, RCAF is lacking, and even the data for the civilian agencies do not add up correctly to the official amount of clearance undertaken in the period.
[45] GICHD/UNDP (2001): A Study of Socio-Economic Approaches to Mine Action, page 9.

in addition to the main action parameters of a programme:

- clearance of mine- and Uxo infested areas, and
- mine risk education and awareness.

The lack of specific knowledge of the impact on such factors on the accident frequency and for the success of mine action programmes in general calls for a more thorough analytical approach. Studies in this field should, however, be based on experience and data from a number of countries and cases over an extended period of time.

4.4 Organisation and main stakeholders

4.4.1 National Level

The Cambodian Mine Action and Victims Assistance Authority (CMAA) was established in September 2000 placed under the direct leadership of the Prime Minister. CMAA currently acts as co-ordinator in the mine action sector at the national level, charged with the implementation of national planning in the mine action sector and with the coordination of information and communication processes, involving all stakeholders; government, service providers and donors. Prior to the creation of CMAA and from the start of mine action in1992, this role was assumed by the Cambodia Mine Action Centre (CMAC), which is now among the service providers for mine action.

According to the decree CMAA is charged with developing policy guidelines and strategic visions on de-mining and UXO clearance and assistance to mine victims, regulation and monitoring of activities and accreditation of organisations involved. Its responsibilities also comprise the development of guidelines on the management of land use on post clearance etc.[46]

CMAA has laid groundwork for coordination by issuing key documents on the assessment of the contamination problem, a strategy for addressing the problem, and a multi-year action plan. Still the National Work Plan 2004 is merely an edition of the collected work plans for the different clearance agencies.[47] This underlines the actual independent role of the clearance agencies acting together with their different donors, and the Government through RCAF. Coordination is slight and all the funding for clearance and other operations is channelled directly to the agencies.

In one important respect, the scope of CMAA extends beyond traditional mine action to embrace post-clearance land use, one of the most important issues in Cambodia today. Efforts to address these post-clearance land use concerns led to the formation of land use planning units at the local level.

4.4.2 Local level participation in planning

The responsibility for the selection of individual mine action tasks will, according to plans, in the future be handled essentially at the provincial level to ensure compliance with national priorities and humanitarian purposes. This is consistent with the decentralisation process promoted by the RGC, and is vital for relevance, success and sustainability of mine action

[46] Kingdom of Cambodia: Legal Framework of Cambodian Mine Action and Victims Assistance Authority CMAA.
[47] Principally the civilian agencies, CMAC, HALO, MAG.

activities. Provincial authorities will act as an interface among de-mining operators, development NGOs and local authorities, communities and target beneficiaries.[48]

As part of sub-national planning, there will be a requirement for mine action activities to be endorsed by provincial authorities as part of their provincial development plans. Transparent, nationally owned and provincial-level led mechanisms need to be in place to address pre-clearance land allocation and post-clearance land use issues through the national regulations and mechanisms.

Authorities in the most mine-affected provinces set in 1999 up Provincial Sub-Committees (PSC), chaired by the vice-governor and including a technical support unit, the Land Use Planning Unit (LUPU). In 2003 a framework more in line with the government's decentralisation policies was proposed, introducing new bodies the Provincial Mine Action Committees (PMAC) and the Mine Action Planning Units (MAPU) at the district level.

The PRDC/LUPU process has been led by provincial authorities in close co-operation with mine clearance operators, and development agencies. It defines, in advance the number and the identities of beneficiaries. The process is community based, participative and decentralized, aimed at identifying in a transparent way those eligible to receive cleared lands. So far this process has been active and operational in five of the most affected provinces: Battambang, Banteay Meanchey, Oddar Meanchey, Preah Vihear and Pailin.

The LUPU mechanism has worked well and, has reduced the number of incidents in which land has been seized by powerful interests after clearance or where cleared land lies idle because of ownership dispute. Still it is clear that not all de-mining agencies take their priorities from the LUPU process. RCAF responds to requests mainly from national ministries or provincial governors, working on national priorities determined from the top rather than on bottom-up priorities identified by communities and development NGOs through the LUPU process.

Other civilian operators regard the LUPU process as too easily 'hijacked' and consult their own information in addition to the LUPU lists. These operators also have to respond to requests from their funding donors, which are not always coordinated with the outcomes of the LUPU process.

The light-handed coordination of mine action can be illustrated by the fact that 36% of the areas cleared in 2003 by the 3 civilian operators were outside the National Work Plan (NWP), even though this plan in its conception was a mere juxtaposition of the plans submitted by the same operators. At the same time 43% of the areas designated in the NWP had not been cleared by the end of the year. CMAA expresses concern about the difficulties encountered by *all* de-mining agencies in the field to follow their work plans, a situation which can create difficulties to plan at the community level.[49]

Due to the transitional situation in 2003 LUPU was not able to provide CMAA with reports regarding the 2004 NWP. Reports from the provinces are, however, expected received for the 2005 NWP from the new MAPU.[50]

4.4.3 Operations level

Mine and Uxo clearance operations within Cambodia are currently operating with a workforce of some 4000 personnel, with in addition hundreds of others in mine action

[48] CMAA: National Mine Action Strategy 2004, chapter 4.2.3.
[49] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 1.1.1.
[50] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 3.2.3.

operations such as mine risk education across governmental and NGOs institutions. The 4 principal actors in mine and Uxo clearance are CMAC, HALO Trust, MAG and RCAF.

Created in 1992, the Cambodian Mine Action Centre (CMAC) is the government's mine-action operator. After the turmoil in 1999-2000, which resulted in a new setup of mine action with policy and regulatory functions clearly separated from implementation, CMAC was reorganised as a service provider only, with responsibilities for mine/Uxo clearance, survey, mine risk education, training etc. A new top management team was in-place by 2001, and by the end of 2003 many former weaknesses had been rectified. CMAC has now a staff in excess of 2,300.

HALO Trust, an international group, started operations in Cambodia in 1992, undertaking emergency survey and de-mining. HALO has grown to become the second largest civilian mine clearance organisation in Cambodia. In line with HALO Trust's overall philosophy, its programme concentrates principally on de-mining. HALO expanded rapidly in size from 560 staff in 1999 to 900 in 2001, to reach almost 1,100 personnel today.

The Mines Advisory Group (MAG) is an international non-profit NGO, based in the United Kingdom and operating in Cambodia since 1992. MAG employs about 500 national personnel at all levels of the organisation, including about 100 women de-miners and about 70 amputee de-miners.

The Royal Cambodian Armed Forces (RCAF) engineering brigades have long been active in de-mining, but it was not until 1999, shortly after the end of the civil war that they were accredited as a humanitarian de-mining organisation. The capacity is significant, with over 690 de-miners. Personnel have received equipment and training from Japan, France, China, and USA as well as from UNTAC.

The commander of the military de-mining units is one of the three deputy secretary generals of CMAA and RCAF has announced its intention to coordinate more fully with CMAA. However, RCAF is not yet a full partner within the national mine action programme, and not all its de-mining activities fall within the policy sphere of CMAA. Information on activities is scarce, and most CMAA statistics on clearance etc at detailed level is presented without any contribution from RCAF.

Since at least 2000 RCAF has been active in conducting survey and clearance operations in support of road construction projects financed in the main by the Asian Development Bank (ADB), putting it in competition with private de-mining firms and, on occasion, with HALO Trust and CMAC.

Other agencies with local affiliation accredited for de-mining have come to the fore recently competing for de-mining tasks on the private market, the Khmer Mine Action Service (KMAS), TADS and MUA.

There is little standardization among the mine/Uxo clearance operators as of the approach to the tasks, the set-up of field work teams, techniques and types of equipment in use etc. This makes comparison of quality of services and costs complicated, in combination with the fact that many of the clients and donors are not too concerned with specifying tasks in a way that can reveal unit costs of different types of services (clearance tasks, various kinds of areas etc).

A variety of other development non-governmental and international organisations are involved with mine action in Cambodia, with fund raising, training, assistance etc.

4.5 Funding

The four operators actually engaged in mine/Uxo clearance under the Cambodian mine action programme, CMAC, HALO, MAG and RCAF are rather independent, subject to slight coordination by CMAA. Competition is limited, as there is no regular practice of putting larger clearance tasks out on tender. Each operator to a large extent benefits from its proper regular sources for funding, comprising:

- Bi-lateral funding from the international donor community sometimes through NGOs (HALO, CMAC, MAG).
- The multilateral UNDP trust fund (CMAC).
- The Government of Cambodia (RCAF and CMAC) among others under its budget for agriculture.

The funding comprises direct payment for specific assignments in area clearance, mine risk education etc, as well as support in the form of equipment donations, technical assistance etc.

All funding for mine action including clearance and mine risk education is channelled from the donors directly to the operating agencies. CMAA, the national regulatory and coordinating authority disposes solely over funds for its proper activities, for the operational expenses of its headquarters, its administrative staff etc.

CMAA's operations are financed partly through UNDP, by donors (technical assistance, equipment etc), and by the Government (salary for national staff etc). The surveys and statistical production of CMVIS is supported by international NGOs (Red Cross etc) and individual donors.

2003	Total cost (operations)	Donors Bilateral	UNDP project and Trust Fund	Government of Cambodia	Capital equipment etc
CMAC	9.25	4.10	5.15	0.10	
HALO	3.45	3.45	-	-	0.29
MAG	3.00	3.00	-	-	
RCAF		-	-		
CMAA				0.06	
CMVIS					
Others					
Total	15.70				
2004					
CMAC	9.83	5.02	4.52	0.15	16.00
HALO	3.77	3.77	-	-	0.26
MAG	3.76	3.76	-	-	
RCAF	4.60	-	-	4.60	
CMAA			0.20	0.07	
CMVIS			0.16		
Others					
Total	21.95				

Table 4.3: Funding of the mine action programme in Cambodia, US$ millions.

Some donors have expressed change in their priorities and have indicated a future decline in funding levels. At this time it is important for the mine action programme to diversify the funding base and supplement the current donors.

To sustain the current high levels of mine action interventions beyond 2012 external funding and other support for mine action in Cambodia may progressively move from being mainly external grant aid to a situation where government or commercial funding prevails. Then mine and UXO clearance will be undertaken mostly by government agencies on a call-out basis or contracted out by the government to commercial firms. Commercial contracts/sub-contracts, executed by commercial, NGOs and/or government operators, will supplement call out work. Mine/UXO awareness will be done primarily through the school system and government-sponsored public education campaigns. Victim assistance will be primarily handled through the governmental and non-governmental medical and social welfare organisations.

4.6 Information and databases

4.6.1 Mine and Uxo victims

The Cambodian Mine/Uxo Victim Information System (CMVIS) was initiated in 1994 as an organisation of the Cambodian Red Cross and Handicap International, Belgium. Since then it has moved to cover the whole country in the year 2001. Incidents are reported on a monthly basis, and additionally trends can be traced back to 1979.

Reports for the last 3 years 2001-2003 have been standardized to facilitate comparison and trend analysis. Information is fairly detailed. Information collection is based on a network of reporters receiving a compensation of US$ 5 for each (human?) casualty reported.

CMVIS neither claims nor intends to capture every occurrence of mine/Uxo accidents in Cambodia. Presently it claims to capture between 80 and 90 % of all casualties. The large efforts to ensure 100% coverage are believed not to justify the resource input needed.[51]

In spite of the excellent information of on mine/Uxo casualties and incidents there are lacking elements in the analysis that could help direct the clearance activity towards the most risky locations. The CMVIS statistics could to a larger extent form basis for improved assessments of which parts of the extensive mined area in the country that are generating the bulk of the mine/Uxo accidents, representing a danger to the people now and in future years with expected population movements etc.

4.6.2 Mine Action Database

By 2003 data on clearance and U.S. bombing was added to the L1S data, with the result termed the National Mine Action Database (NMAD). Actually NMAD is the primary repository of all mine related information within the Kingdom of Cambodia, and has the capability to produce mapping products, reports, and statistics for all stakeholders.

NMAD provides CMAA with information to facilitate planning, management and reporting of mine action operations. It provides data-collection capability, tools for analysing and examining this data (including GIS), and the means to disseminate the processed information.

[51] CMVIS (2001): Mine and Uxo Casualties in Cambodia 2000, page 9-10.

NMAD now uses the Information Management System for Mine Action (IMSMA) which has been customised to meet the specific requirements of the mine action programme in Cambodia. Using IMSMA reporting functionalities, CMAA will report quarterly to the Government, donors and United Nations Agencies on basis of reports from de-mining operators on a regular basis.

The CMAA database on cleared areas needs to be consolidated, so that it can provide official figures for clearance on location (province, district), types of areas, techniques etc for the individual years since the start of the mine action programme. As of today this information exists on different files which can be incomplete and inconsistent.

More information about the cost of clearance and of conducting other mine action activities should be required from the operators. As a first approach the operators could supply information on clearance time (in hours) of different tasks as an element to the CMAA database on cleared areas (see also chapter 7).

The extent of the mine/Uxo infested area in Cambodia is disputed; in particular what parts of it should be given priority for clearance. It is strongly recommended to revise the estimates of the contaminated area as basis for further analysis of risk reduction etc (see chapter 5).

4.6.3 Socio-economic information

From 1992 to 2000 socio economic information was scattered and difficult to compare since the criteria had not been the same for all operators. As a result few reliable data were published.

Socio economic data from operators have been collected with the forms put in the guidelines issued by the CMAA in 2003. Unfortunately, the relevant tables have not been comprehensively filled in by the operators, as some data were difficult to find the first year of implementation.[52]

The CMAA Socio-economic Cluster, established in January 2004, has been set up to coordinate this data gathering. The CMAA Socio Economic Guidelines were discussed and adopted at workshops gathering all stakeholders in December 2004.

The Socio-economic Cluster should in particular have a responsibility with following up the cost-benefit analysis.

[52] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 2.2.

5. Reducing the human loss

5.1 Accidents risk

The Cambodian National Mine Action Strategy 2004 states that clearance of the worst-affected areas will be given priority to reduce as soon as possible the risk of death or injury to individuals living in landmine/Uxo -affected areas. This reduction of the impact of mines/Uxo will be carried out as quickly as possible by increasing outputs coupled with improved targeting of the most affected areas.[53] According to the Strategy the current distribution of existing mine clearance capacities in the country could be able to clear the remaining parts of the severely of contaminated land by 2012-2015. It further targets a decrease in the number of mine and Uxo accidents towards a minimum at the end of the same period.

Considering a specific mine- and Uxo infested area; the effect of clearance on accident risk reduction will depend on the danger this area represents to the local community, visitors, and particularly to people moving in. The number of accidents and incidents experienced recently may give an indication of this, but accident rates at the local level can be relatively small numbers, subject to random variation from a year to another.

Some measure of the actual threat an area constitutes could be based on experience over many years or from other places under similar circumstances, identifying concrete risk factors related to the type of mined area, its proximity to large populations, the obstruction it represents to important activities and infrastructure etc. Given certain conditions one should not have to wait for a sufficient number of accidents to take place before moving into action, but as indicated (chapter 4.3) studies demonstrating this connection are scarce in Cambodia and elsewhere.

Furthermore it is generally admitted that while the clearance of minefields can reduce the number of mine accidents, other measures like mine risk education will have to be strengthened in order to reduce the number of Uxo casualties. In this cost benefit analysis it is therefore assumed that while reductions in the mine accidents rate can be achieved through clearance of suspected areas, only 30% of the Uxo victims will be affected by clearance. The remaining 70% of the Uxo problem will have to be addressed otherwise.

Finally, on a realistic assumption, after clearance of these areas an estimated 10% of the mine and Uxo accidents may still persist, not on the cleared land, but on low priority or outside areas that failed to be identified at the outset.

For this cost benefit analysis a specific estimate of the high priority contaminated land is proposed (discussed in chapter 4.3). It consists of the CMAA/L1S severe and high priority categories for the provinces where these constitute the largest areas, and of the data from the operators for the provinces where these are the most extensive. The resulting figure has then been reduced by 25% so as to end up in line with the CMAA/L1S estimate of total severe and high priority contaminated land in Cambodia, which is about 300 km^2.

In the further analysis this area will be considered the principal source of mine and Uxo (30%) accidents in the country and the individual provinces, while underlining that the estimate is preliminary, to be exchanged for a better one when such data become available.

It has been difficult to trace any clear trend in the development of accident rates for the last years on the national or the provincial level (see chapter 4.3). It is therefore suggested to base the accident rate on an average for the 4 last years 2001-2004. Including all the mine

[53] CMAA (2004): National Mine Action Strategy 2004, chapter 4.2.1.

accidents and 30% of the Uxo accidents, this will amount to an average of 513 casualties representing the “actual” accidents level in the country.

It is further presumed that this casualty rate can be reduced progressively through clearance of the contaminated areas described above comprising a total of 304 km^2, while retaining the assumption that 10% of the accidents will “linger on” as a consequence for example of difficulties with targeting the right areas.

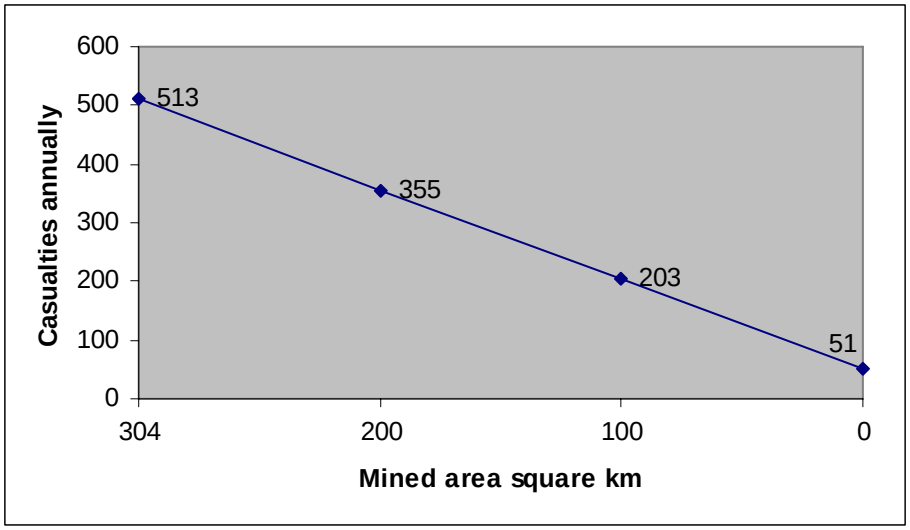

Figure 5.1: The annual number of casualties related to the extent of the mined area.

Figure 5.1 illustrates the presumed connection between the casualty rate and the extent of the mined area. According to this model the identified priority mined area of 304 km^2 generates 513 mine and Uxo casualties annually, and this is supposed to describe the current situation in the country. Clearance of contaminated land entails declines in the number of casualties; a remaining mined area of 200 km^2 for example would, according to figure 5.1, be expected to cause 355 victims on an annual basis.

As an average for the whole country, clearance of 1 km^2 will reduce the casualty rate with 1.5 mine/Uxo victims annually, and clearance of 1 km^2 now will equivalently reduce the number of accidents with 15 in total over a 10-years period. The model further assumes that clearance of all the priority areas will not reduce the number of casualties to 0, since 10% or 51 casualties is expected to persist as the annual rate.

Table 5.1: Clearance efficiency at the provincial level.

Provinces	Suspected area in km^2.	Mine casualties + 30% Uxo, annual average 2001-04	Victims when mined areas are cleared	Victims reduction annually per cleared km^2.	Reduction in a 10 years period
	a	b	c = 10%* b	d =(b-c)/a	e = d *10
Battambang	72	147	15	1.8	18
Pursat	39	18	2	0.4	4
Siem Reap	38	17	2	0.4	4
Otdar Meanchey	31	51	5	1.5	15
Banteay Meanchey	57	109	11	1.7	17
Pailin	14	57	6	3.8	38
Kampong Thom	3	8	1	2.2	22
Kampong Cham	15	24	2	1.4	14
Kampong Speu	2	7	1	3.5	35
Kracheh	2	9	1	4.7	47
Preah Vihear	14	25	3	1.6	16
Others	17	37	4	2.0	20
Total	304	513	51	1.5	15

The same approach has in Table 5.1 been applied on data disaggregated to the provincial level. Information of the suspected area in each province (a) and the annual number of mine/Uxo casualties (b), together with the assumption that 10% of the accidents (c)[54] still persists after the suspected area (a) has been cleared, has been used to calculate the expected reduction in casualty numbers as a result of the clearance activities (d).[55] The figures in this column thus show the impact from clearance of 1 km^2 of priority area towards reduction of the number of casualties actually experienced in that province. This factor (d) can be called the "clearance efficiency rate." The reduction over a 10 years' period from clearing 1 km^2 (e)[56] is equivalent with the annual reduction from clearing 10 km^2.

The table reveals some significant differences among the provinces regarding the clearance efficiency rate. When the principal objective is to reduce the number of mine/Uxo casualties as quickly as possible within limited budgets, it appears that resources for clearance activities could be spent more efficiently when directed to certain provinces as compared with others.

In Pailin a relatively high number of accidents (57) appear to be generated by a fairly limited extent of mined area (14 km^2). This constellation results in a rather high clearance efficiency rate, a reduction of 3.8 victims annually or 38 victims over a 10 years' period for each km^2 cleared. Pailin is among the seriously affected provinces regarding accidents, while clearance started only in the year 2000.

Among the accident prone provinces where large scale clearance has been going on since the beginning of the mine action programme, Battambang and Banteay Meanchey also come out with clearance efficiency rates above the average. Battambang is exposed to a level of mine and Uxo accidents, which is for most years by far much higher than in any other province in Cambodia, and the bulk of the Five Year Plan priority areas are also located there.

[54] c =10% of b
[55] d = (b-c)/a
[56] e = d * 10

Siem Reap and Pursat appear to come out on the lower side regarding clearance efficiency rates, indicating larger extents of suspected areas as compared to more moderate accident levels there.

The three provinces Kampong Thom, Kampong Speu and Kracheh all have high clearance efficiency rates. These are provinces, however, where Uxo accidents dominate completely; altogether there were 3 mine accidents and 55 Uxo accidents in these 3 provinces combined in 2004. Their high efficiency rates as observed here are thus conditioned on the assumption that land clearance activities can have an impact on at least 30% of their present Uxo accidents level. Kampong Cham which had 4 mine casualties and 72 Uxo casualties alone in 2004 comes out with a lower efficiency rate, because more contaminated area has been identified there.

Table 5.1 represents an attempt to locate regions or areas where clearance can be expected to have more significant impacts on the accident rate, and conversely where it could be a costly task, contributing only in the long run towards reduction of the number of casualties. The conclusions will of course depend on the quality of the data input; here in particular the estimates of the extent of the priority mined area and its distribution on provinces.

Furthermore the conclusions will be valid in cases when the accidents are found to be widely and evenly distributed over the whole extent of the priority area identified in the province. Since most provinces are large there might, however, be specific clearance tasks with higher efficiency rates in some places than in others. Still, this would necessarily have to be evened out by low efficiency tasks in other localities, which should then be reclassified so as not to appear among the high priority impact areas.

In this way the suspected area could be progressively reduced or put into appropriate priority categories. For the time being, however, the clearance efficiency estimates in table 5.1 may have to pass on a preliminary basis.

5.2 Productive value

The appraisal of the gains from mine action towards reduced human loss will be based on calculations of the potential contributions from an average Cambodian mine victim to the productive activities of the country. Furthermore an estimate of the value of leisure time will be added. This must not, however, in any ways be conceived of as the value of a human life. Still it is in line with benefit calculations regularly undertaken by other types of initiatives aimed at saving lives and reducing accidents risk, for example in road safety programmes.

The average, annual household income levels in rural areas in provinces affected by mine/Uxo accidents can be ranged between US$ 300 and 700.[57] For adult victims it can be assumed that the family breadwinners are the ones most exposed to mine/Uxo accidents risks. Males are the most frequently represented among the mine/Uxo casualties, while women victims may come from women-headed households (table 3.2). The typical adult victim's potential for income generation could thus be fixed rather towards the upper level, and a share of non-marketed subsistence production value will also be added.

This cost benefit analysis will thus be based on an annual income of US$ 1000 per adult mine victim. By using figures for average incomes unemployment rates will not have to be taken into account. Unemployment is a complicated issue in rural Cambodia, where a large share of

[57] Asian Development Bank (2001): The North-western Rural Development Project, page 3.

the population works as unpaid farm labour, being productive while not receiving any money remuneration.

An average adult mine/Uxo victim could have a potential revenue-generating life-time of 35 years. For a child the average life expectancy is estimated to 45 years, including 5 years of non-productivity in the beginning.

In addition to the productive value (contribution to GNP) a value of leisure time has been added, stipulated to an equal amount, US$ 1000 per year, children and adults on the same level.

The country's National Poverty Reduction Strategy confirms the government's aims to achieve a sustainable real rate of economic growth of 6% to 7% per year, to reach an income per head of US$320 at the end of 2005. This represents an annual growth rate in real income per head of 3.5%.[58]

The last goal, the growth in income per person, will be the proper basis for an estimate of the increase in production generating capacity expected for a Cambodian over the coming years, the potential revenue lost in case of mine victims. For the first 10 years the economic growth per capita is thus fixed at 3.5%, in a longer perspective, however, the analysis will settle with an estimate of 2.5% growth.

Estimates of future economic growth will enter into the analysis in different ways: First it will affect the future production potential for a typical mine/Uxo victim of today over his/her lifetime that is to say over an estimated span of 35 years for adult victims and 45 years for children from now on. Secondly it must be taken into account that without clearance new accidents will continue to occur also in future years, a period of 20 years has been considered here. Because of the economic growth victims in those future years will have reached a higher income level than today's victims. The potential production lost with those victims will therefore have to be calculated starting from the actual income level in the year when the accident happened.

The analysis furthermore takes into account the difference in frequency of adults and children among mine and the Uxo victims (with an average for all provinces) where, according to the assumptions described above, only 30% of the Uxo casualties have been included.

The subsequent calculations result in an economic loss concerning a fatal casualty amounting to about US$ 25,000 on the average when today's productivity level is the starting point. The annual production value the victim could have contributed has then been discounted over the victim's potential lifetime at a 10% rate. For future victims this value will be increasing with the level of economic growth.

5.3 Medical costs

The International Committee of the Red Cross (ICRC) estimates an average hospital stay for patients with mine injuries to be 3 weeks, amputees stay almost 5 weeks and require on the average 4 operations as well as antibiotics and blood transfusions. In addition amputees should have prostheses replaced every 3 to 5 years or every 6 months for children. These medical costs have been estimated (G Harris 2000) to US$ 550 on an annual basis.[59]

[58] Council for Social Development (2002): National Poverty Reduction Strategy 2003-2005, chapter 4.1.1.
[59] G Harris (2000): The Economics of Landmine Clearance. Case Study of Cambodia (Journal of International Development 12 – 2000) page 221.

In the CMVIS statistics victims are classified into the categories of deaths, injured and amputations. For the years 2002 and 2003 the victims are distributed as follows:

- Deaths: 16%.
- Amputations: 23%.
- Injured: 61%.

In Cambodia it is realised that only a small number of the mine/Uxo victims receive rehabilitation assistance from national and international organisations.[60] An estimate could therefore be that on the average only a half of the amputees receive the above prescribed treatment and that a half of the injured victims receive a more limited treatment amounting to 50% the full cost. It could, however, be assumed that over the years to come there will be an increase of 2% annually in the number of people treated or the amount allocated for such treatment.

The annual amounts will be discounted over the lifetime of the individual victims. The analysis will then proceed to calculate the medical costs related to a future loss of one victim annually over the analysis period, that is to say the next 20 years. With an analysis similar to the one above it will then be taken into account that future victims start with a more comprehensive treatment already at the outset.

5.4 Economic gains from reducing the accident risk

Table 5.2 is summing up the economic loss related to mine/Uxo victims, when it is assumed that a contaminated area is claiming one victim annually over the period under consideration, that is to say 20 years.

Table 5.2: Total economic loss for typical victim and categories of mine/Uxo victims

One victim every year over 20 years		Disability %	US$	% of victims	US$
Death (fatal casualty)		100 %	259 510	16 %	42 156
Amputation	Productive loss	70 %	181 657	23 %	41 179
	Medical costs		31 845		7 219
Injured	Productive loss	40 %	103 804	61 %	63 411
	Medical costs		15 922		9 726
Economic loss average casualty, one victim every year over 20 years, US$					163 691

- In connection with a fatal casualty the economic loss is total and there will be no medical costs. Deaths comprise on the average 16% of the total number of victims.
- An amputation is considered a 70% disability; the production loss will therefore be 70% compared to a fatal casualty. In addition there will be medical costs (as explained in chapter 5.3). On the average 23% of the victims have to undergo amputations.
- Injured persons are considered to be disabled at 40%, and the productive loss will be accordingly. There will also be medical costs connected to the treatment of injuries, but amounting to only half the cost of treating amputees. Injured persons comprise 61% of the mine/Uxo victims on the average.

[60] Cambodia Millennium Development Goals Report 2003 (November 2003) chapter 2.9.4.

A contaminated area expected to claim one victim per year actually and in the future will thus cause an accumulated human loss over a 20 years period amounting to about US$ 163,000 in economic terms. Future production losses and medical costs for different categories of victims have then been discounted into today's present value.

For the mine/Uxo exposed provinces of Cambodia in total it has been estimated that clearing of one km^2 of mine/Uxo contaminated land could on the average reduce the accident rate with about 1.5 victims annually that is to say with 15 victims over a 10 years period. This rate has, however, been found to vary with province (table 5.1), an this will have to be taken into account when estimating the total economic gains from clearance of land there.

Table 5.3: Reduced human loss in economic terms from clearance of 1 km^2 of land, net present value over 20 years in 1000 US$.

	Economic gains 1000 US$
Battambang	300
Pursat	70
Siem Reap	64
Otdar Meanchey	241
Banteay Meanchey	283
Pailin	614
Kampong Thom	365
Kampong Cham	235
Kampong Speu	566
Kracheh	768
Preah Vihear	268
Others	323
Average	249

The observations from table 5.1 on the variations of clearance efficiency rates among the provinces are in table 5.3 transferred into economic terms. The figures in table 5.3 can be compared directly with the clearance cost of 1 km^2 contaminated land.

It appears that clearance tasks in provinces like Pailin, Kracheh, Kampong Speu and to a lesser degree also Kampong Thom and Battambang, come closest to defend clearance costs on the account of reduced human loss. Provinces like Siem Reap and Pursat will have the largest difficulties with reaching up.

In most cases additional benefits from using the cleared areas for productive purposes like agriculture, infrastructures etc may be required in order to fully meet the clearance costs (see chapter 6). The reservations made above on the quality of data are, however, still valid, concerning in particular the need for revision of the estimates on priority suspected areas.

Applied in analysis for future years, 2006 and onwards, the benefit estimates in Table 5.3 should be updated according to the development of the Cambodian GDP per capita.

6. Mine action for development

6.1 Clearance for agricultural purposes

The agricultural land cleared under the Cambodian mine action programme is specifically destined for distribution among the poorest parts of the population. It is therefore not expected that modern agricultural techniques and equipment will be used in the near future, which will also be reflected in the yields and in the amount of input etc.

The staple food item in Cambodia is rice. The output from rice production will therefore be used as a guideline for the production value of agricultural areas. Small farmers use their areas also for fruit growing, vegetables etc, but output from such crops would usually not come in addition to, but rather replace some of the rice crop.

Livestock production may on the other hand be a complementary trade, since animals to a large extent can be fed on waste produce from the agriculture.

Provinces	Paddy yield Tonnes per ha		Dry season crops %	Net yield Tonnes per ha and year	Paddy farm gate price US$/tonne. [61]	Paddy crop margin US$/ha/year	Animals per ha farmland	
	Wet season	Dry season					Pigs	Poultry
Battambang	1.6	3.0	1 %	1.4	97	111	0.4	4
Pursat	2.3	2.4	3 %	2.1	87	142	0.9	31
Siem Reap	1.3	2.5	7 %	1.2	97	95	0.7	5
Otdar Meanchey	1.1		0 %	0.9	89	67	3.3	28
Banteay Meanchey	1.4	2.5	0 %	1.2	98	97	0.4	3
Pailin	1.8	2.0	19 %	1.9	89	136	4.4	40
Kampong Thom	1.8	2.6	5 %	1.7	96	129	0.7	6
Kampong Cham	2.4	3.2	37 %	3.1	102	253	1.5	11
Kampong Speu	1.6	2.5	2 %	1.4	94	109	1.7	16
Kratie	2.1	2.7	38 %	2.7	102	223	3.3	13
Preah Vihear	1.5		0 %	1.3	83	86	1.7	18
Average	1.7	3.2	15 %	1.9	94	142	1.2	10

Table 6.1: Agricultural production in mine action provinces.[62]

The information of paddy yield shows variations in output and practices over the provinces. Dry season yields, being dependent on the access to irrigation water, are significantly higher than the wet season yields. In many regions, however, the dry season crops are small, only a limited percentage of the area is replanted. These factors are combined in the calculation of the "net yield in tonnes per ha and year." Here is also taken into account that an estimated 13% of the crop is retained as seed for next year's plantation or lost/wasted.

The farm gate price for paddy also shows some regional variations and is relatively low in general. This information was collected in December 2003 for the Seila village database.

In the absence of more accurate information it has been assumed that 20% of the value of the paddy production covers the cost of input factors. A large majority of the poor farmers will use animal draught power and little artificial fertilizers and pesticides. Some of the household members may have different options for work (in Thailand etc), while women, elderly people

[61] Source for price information: Seila village database – December 2003.
[62] Source for agricultural produce and practices : FAO Annual report 2002.

and children may only be employed in farm work. Their labour input could therefore have a low alternative cost.

On basis of this information can be calculated the paddy crop margin in US$ per ha per year. These annual net revenues from paddy cultivation are widely varying among the provinces.

Information is available about the livestock population in different provinces. It is here assumed that the stock of pigs and poultry a particular year is roughly equivalent to the production output for sale or own consumption. The livestock population is further assumed related to the extent of the cultivated area in the province. Table 6.1 thus shows the number of pigs and poultry per ha cultivated land.

It is assumed that pigs and poultry live off wastes from the farmland, the crops or from adjacent forest areas, so that there may be few input factors connected with raising them. Those who are not bred for consumption within the farmer's household will be sold alive. Most of the labour input will also be performed by household members with few alternative occupations.

According to the Poverty Reduction Strategy the agricultural sector in Cambodia is growing at a rate of 3.6% annually, but output experiences large year-to-year fluctuations, reflecting insufficient investment in the sector, over-exploitation of natural resources, and precarious weather conditions.[63] A long-term annual productivity increase of 2% has thus been found appropriate and is built into this analysis.

The value of agricultural production has been considered over 20 years, discounted to present value at a rate of 10%. The market value of the land at the end of the period has been estimated to 5 times the value of the produce for the last year.

The fear that it might be mined is in many places in Cambodia an important reason for not taking agricultural land into use, and in some instances this fear might be based on lack of information. When de-mining is taking place in a region it will presumably be possible also to open up land adjacent to the actual minefields, by applying various techniques for reducing the suspected area at considerably less cost than full clearance, marking and sealing off mined areas from non-contaminated land etc.

Only site specific information can decide whether this is the case and to what extent. Here the extra benefit in this respect is estimated preliminarily to an additional 30% of land which can be settled, planted and harvested etc.

[63] Council for Social Development (2002): National Poverty Reduction Strategy 2003-2005, chapter 4.1.1.

	Farm revenues per square km land, 1000 US$		
	Annual	Net present value over 20 years	
		Cleared land	+ 30% land
Battambang	14	152	197
Pursat	25	266	346
Siem Reap	14	151	196
Otdar Meanchey	28	305	397
Banteay Meanchey	12	133	173
Pailin	44	470	612
Kampong Thom	18	191	248
Kampong Cham	35	375	487
Kampong Speu	23	243	316
Kracheh	41	444	577
Preah Vihear	21	224	291
Average	22	240	311

Table 6.2: Revenues from 1 km^2 of agricultural land, US$ per year and net present value over 20 years, with an additional 30% of land made available.

In Table 6.2 the net revenues from paddy farming and from rising livestock are combined and related to the cultivation of 1 km^2 of land. Revenues are found to be highest in Pailin and Kracheh, more than 3 times higher than in Banteay Meanchey, Siem Reap and Battambang.

Agricultural areas in Pailin, Kracheh and Kampong Cham will provide the largest contribution towards covering their clearance costs. Areas in Banteay Meanchey, Siem Reap and Battambang will have much more difficulties with justifying clearance demands when counting agricultural benefits only.

The revenues from agricultural production will apparently on their own account have difficulties with justifying the cost of mine/Uxo clearance in many areas; this conclusion seems valid for the majority of the provinces in Cambodia. The explanation lies in the generally low yields of rice and in rather low farm-gate prices for the produce. From table 6.1 it is clear that access to irrigation water in the dry season could improve the situation very much. Production in the dry season could also presumably be sold at a higher price than can be obtained at the end of the wet season (December).

There is a challenge towards gathering more socio-economic data on the total benefits to the local community from clearance of land. The question could for example be how much more land can be distributed for resettlement and agricultural use as a direct consequence of clearance of some specific land. In some instances more land than that which was cleared could be taken into use, and such cases would be important to have knowledge of at the planning stage.

In the socio-economic reports there is already provision for registration of indirect beneficiaries from the land cleared, in addition to those beneficiaries directly taking into use formerly contaminated areas. As of the Work Plan for 2004 the direct beneficiaries are counted to 11,000 families and the indirect to 71,000 families.[64]

[64] CMAA: Mine Clearance Analysis and Guidance 2004, chapter 2.2.2.

Cost benefit analysis for future years should update the revenue estimates in Table 6.2 with the development in the price of paddy and livestock.

6.2 Irrigation canals

Mine clearance related to irrigation canals and systems aims at reopening the possibility for irrigation of agricultural areas. Clearance of the canal area will therefore presumably benefit a much wider extent of agricultural land. In specific cost benefit analyses this relation will vary from case to case, and little information is currently available for concocting a general case.

A possible assumption could therefore be that 1 km of irrigation canals will allow dry-season irrigation and planting of 1 km^2 agricultural land. The canal will presumably have to be cleared in a 20 m wide sector on each side (40 m in total), so that a 1 km long canal will constitute a clearance task of 4 ha or 0.04 km^2.

Access to irrigation water provides opportunities for dry-season crops. The irrigated land generally produces higher yields than wet season plantations (Table 6.1), with some variations as of province. The benefits from clearing a 1 km long canal will accordingly comprise the extra net revenues to the farmers from dry season crops on 1 km^2 of land. There will presumably be no effect on livestock production while the other elements in the analysis of agricultural production (chapter 6.1) remain unchanged.

Some provinces in Cambodia appear to offer few possibilities for dry season replanting as of the statistics. They will not be included here, but specific cost benefit analyses should look into such opportunities from case to case.

	Farm revenues per sq km land, 1000 US$	
	Annual	Net present value over 20 years
Battambang	20	219
Pursat	15	158
Siem Reap	17	180
Otdar Meanchey	0	0
Banteay Meanchey	17	182
Pailin	12	133
Kampong Thom	17	186
Kampong Cham	23	244
Kampong Speu	17	177
Kratie	19	204
Preah Vihear	0	0
Average	21	223

Table 6.3: Dry season crop revenues from 1 km^2 irrigated agricultural land, US$ per year and net present value over 20 years.

Table 6.3 shows the net extra benefits to farmers from access to irrigation water in the dry season. There are some regional variations.[65]

[65] The revenues in table 6.3 are lower in many cases than those in table 6.1, among others since no extra incomes from livestock are presumed.

The main point is, however, that the extra net revenues per km^2 of irrigated land in table 6.3 are benefits resulting from the clearance of a much smaller area, an irrigation canal of 1 km length, which could constitute a clearance task of not more than 0.04 km^2.

Assuming for example a clearance cost level of US$ 0.9 per m^2, or US$ 900,000 per km^2, the clearance of a 1 km irrigation canal would cost about US$ 36,000 which is the figure to be compared with the "net present value over 20 years" in table 6.3.

As this comparison shows, in all cases and provinces the benefits from clearance of irrigation canals have no problems with justifying the clearance costs. Such tasks should in fact be undertaken even if the clearance costs for some reason were substantially higher or the irrigation canal needed considerably longer than the 1 km considered here.

6.3 Loss of livestock

The number of livestock killed or injured in mine/ Uxo accidents is given in table 6.4 as of CMVIS statistics. On the average a loss of about 50 animals is reported annually over the period 2001 to 2003. The number seems to have decreased substantially, which could be a benefit from clearance. There is, however, a report of 40 cows from the Battambang province in 2001 which stands out as rather exceptional.

If these figures tell the whole story the losses of livestock do not amount to much in economic terms. Even if the value of an animal is estimated as high as US$ 500, the loss will comprise less than US$ 85 per km^2 priority area per year on the average.

	2001	2002	2003	Average
Cows	76	38	12	42
Buffalos	1	6	1	3
Horses	1	1	1	1
Other animals	4	3	7	5
Total	82	48	21	50

Source: CMVIS: National Census 2001-03.

Table 6.4: Livestock killed or injured at mine/Uxo incidents.

Most likely there is an underreporting of animals killed or injured in mine accidents in Cambodia. In the best case the figures in Table 6.4 seem to comprise only incidents where also humans were injured or killed. Moreover the figures in Table 6.4 are contradicted by other observations that 14% of the villagers in Cambodia had lost at least one animal to landmines.[66]

These are indications that landmine damage to domestic animals might constitute a more significant economic loss; in Afghanistan very high losses were indeed reported. This could call for an improved reporting system of damage to domestic animals by landmines. The most practical approach could be to improve the CMVIS reporting system so that animals killed and injures to animals are recorded regularly as part of the monthly census, also including incidents with no damage to human beings.

[66] Level One Survey, referred in CMAC: Annual Report 2003, page 2.

6.4 Transport systems

"Improved roads" is often quoted as first priority when villagers in Cambodia express their preferences for infrastructure. Transport facilities often constitute a key factor, leading to increased agricultural production, more land under cultivation and intensified land use, as farmers take advantage of expanded market opportunities.

Rural infrastructure is inadequate in Cambodia, with extremely poor transport links. The rural road network is often in disrepair rendering roads impassable, especially during the wet season. In addition, many of these rural roads pass through minefields or areas littered with Uxo. The mine action programme cleared 313 km of roads in 2003, while 29 km are planned cleared in 2004 according to the National Work Plan (without RCAF which has been extensively engaged in road clearance).

Clearance of roads will benefit persons and vehicles using the road in the form of more convenient transport opportunities, reduced travel time and travel costs. Mine-contaminated road links may generally hinder road users from travelling the shortest route to their destinations. In this analysis it is presumed that a kilometre of mined roads will cause diversion of traffic onto other links of double distance on the average. The benefits from clearance of 1 km of mined roads will thus consist of the savings to road traffic and transport from travelling a 1 km shorter route.

This assumption has been made in order to concoct a general case. Specific cost benefit analyses should reflect the local conditions and take into account actual travel distances at alternative routes. The salient issue will be the difference between the travel distances on the reopened road compared to the alternatives the traffic had to use before clearance.

	Ox-cart	Bicycle	Motorbike	Motor-trailer	Car/pickup	Truck
Daily traffic (annual average)[67]	19	13	297	26	19	5
Generated traffic 40%	8	5	119	10	8	2
Speed km/hour	2	5	15	10	15	15
Passengers per trip	2	1	3	5	10	10
Reduced travel distance, km	1	1	1	1	1	1
Reduced travel time hours per year	6650	910	20790	4550	4433	1167
Value travel time US$/day	0,23	0,23	0,23	0,23	0,23	0,23
Value of reduced travel time in US$/year	191	26	598	131	127	34
Vehicle operating cost US$/km	0.001	0.001	0.07	0.1	0.1	0.36
Vehicle operating cost US$/year	7	5	7277	910	665	630
Reduced time cost generated traffic US$/year	38	5	120	26	25	7
Reduced VOC generated traffic US$/year	1	1	1455	182	133	126
Total gains US$/year	237	37	9449	1249	951	796

Table 6.5: Transport and traffic analysis.

Information about annual average daily traffic has been obtained from counts undertaken by the Tertiary Roads Improvement Programme (TRIP) on rural roads. The clearance is thus presumably concerned with rural or tertiary roads. Here a large part of the traffic consists of motorbikes.

[67] Source: The Tertiary Road Improvement Programme (TRIP)

Information about passenger numbers, vehicle operating costs (VOC) for categories of vehicles and the value of travel time has to some extent been obtained from the ILO Upstream Project. Data have however, been modified somewhat for use in this analysis. It is assumed that reducing the travel distance to the half will increase traffic by 40%.

The shorter travel distance will reduce time on the road for the persons travelling. These gains can be evaluated by an assumption of people's willingness to pay for time savings. Shorter distance to destination will also generate savings related to vehicle operations, for each category according to their specific unit costs. Benefits for generated traffic have, according to standard cost benefit techniques, been evaluated relative to the consumer surplus.

The savings for motorbike traffic and in particular their VOC, will as expected form the most important benefit component related to improvement of the rural roads network. Other groups of road users contribute much less. In total, however, the amount is considerable, about US$ 13,000 on an annual basis.

	Annual	Net present value over 20 years
Benefits from clearance of 1 km of rural road, 1000 US$	13	108

Table 6.6: Mine clearance of rural roads, annual and net present values in 1000 US$.

The annual benefits have then been discounted over a 20 years' future period into a net present value. This value can be compared to the clearance costs of 1 km of rural roads.

The Asian Development Bank (ADB) requires de-mining of rural road alignments to a width of 20 metres on each side of the road centreline.[68] Taking this requirement into account a 1 km road link will constitute a clearance task of 4 ha or 0.04 km^2.

Assuming for example a clearance cost level of US$ 0.9 per m^2, or US$ 900,000 per km^2, the clearance of a 1 km road link would cost about US$ 36,000 which can be compared to the net present value over 20 years in table 6.6 of US$ 108,000.

Still the state of repair of the road ought to be taken into account. Clearance tasks regularly form integral parts of rural roads rehabilitation programmes. Rehabilitation of rural roads may cost at least US$ 6,000 per km (upgrading).[69] The actual need must be assessed from case to case.

Clearance tasks on rural roads thus appear to be well capable of defending their cost. In case the cleared road should replace alternative links which are only 50% (or ½ km) longer, the benefits will be reduced to the half or about US$ 54,000. Still this would exceed normal road clearance costs by a clear margin.

6.5 Schools

School attendance is low in Cambodia, and where schools exist, class sizes are frequently large, 50 children per class or more. Often two or three shifts a day are needed due to the limited number of classrooms. Schools are frequently dilapidated, old buildings or very simple wooden framed, open-sided structures with thatch or corrugated iron roofs. In some places, classes are held in private houses in the absence of other facilities.

[68] Asian Development Bank (2001): The North-western Rural Development Project, page 16.
[69] NCG (2004): Rural Infrastructure Development in Cambodia, page 53.

A total of 61 schools were cleared under the mine action programme in 2003 (by the civilian agencies), constituting an estimated 4% of the cleared area, while 41 schools have been identified for clearance in the Work Plan for 2004.

It could be assumed that a school constitutes of 2 shifts of classes with 40 pupils in each so that 80 pupils[70] attend the school every day, 6 days a week for 40 weeks a year. The village school premises have been mined, however, so instead of attending the nearest and most convenient location, the pupils have to travel and crowd in on schools in other villages. The extra travel distance could be 5 km each way on the average for each of them. An assumption can also be made that 80% the pupils are travelling by bicycle with 2 on each and 20% as passengers on motorbikes, with 2 pupils each bike.

The socio-economic cost of this extra transport will then comprise the operational costs of bikes and motorbikes for all the 2 x 5 km return trips needed every day of the school-year plus the extra time costs of the pupils and the motorbike drivers.

Pupils per class	40	
Number of shifts a day	2	
Days a week	6	
School weeks a year	40	
Extra distance to school km	5	
Trips to and from a day	2	
	Bicycle	Motorbike
Mode of travelling	80 %	20 %
Pupils per mode of transport	2	2
Driver		1
Number of transports a day	32	8
Travel speed km/hour	5	15
Value of travel time US$/day	0.15	0.23
Vehicle operating cost US$/km	0.001	0.07
Time cost annually US$	576	85
Travel cost annually US$	77	1344

Table 6.7: School attendance and cost of transport to school.

Table 6.7 gives the input information used in the analysis. For the vehicle operating cost the assumptions correspond to those applied in chapter 6.5 on road transport. Value of travel time has been reduced to US$ 0.15 a day for the children, retaining US$ 0.23 for the motorbike drivers. The time loss and costs will be highest for bicycle transport (also with a 50%-50% share), while the higher vehicle operation costs make motorbike a far more expensive mode.

	Annual	Net present value over 20 years
Benefits from clearance of school premises, 1000 US$	2.1	18

Table 6.8: Benefits from clearance of schools, 1000 US$ annually and net present value over 20 years.

[70] The 41 schools planned for clearance in the NWP for 2004 comprise 7082 pupils or over 170 pupils per school (NWP chapter 2.2.3).

As table 6.8 shows the total net benefits from clearance of school areas, resulting in reduced need for travelling to schools in distant villages, amount to about US$ 2,100 annually or US$ 18,000 as net present value over a 20 years' period. The last figure can be compared with the clearance cost of school areas.

Based on information from previous clearance tasks, a school area can be estimated to about 1.2 ha on the average. A clearance cost of US$ 0.9 per m^2 would thus amount to US$ 10,800 for a school area of 1.2 ha, which is well below the estimated benefits of US$ 18,000. Such tasks could be justified even in cases when the areas to be cleared were considerably larger, or the children were able to find alternative school facilities within closer range. For schools with larger numbers of pupils than the 80 considered, the benefits would increase proportionally.

6.6 Wells and water supply

Lack of clean domestic water is a major problem for many rural people in Cambodia, especially in the dry season. Most rely on shallow dug wells or nearby rivers for household water and many have to travel long distances to the closest source of supply. The costs connected to the provision of water supply comprise more than the eventual drilling and construction of the well. Usually there will be a considerable amount of planning and field research connected in order to provide stable and safe supplies with enough water also in the dry season, together with institutional components to secure sustainability. Donor programmes in this field tend to be costly.

Wells are thus not easily replaced, and when a well has been mined the alternative supply may be located far away, be contaminated or prove insufficient for the demand, so that the users will have to line up and wait, sometimes for hours. In times of shortage one member may have to be constantly occupied with the provision of water for the family. This task will often fall on one of the children, being then prevented from attending school.

A total of 130 wells were de-mined in 2003, and estimated to comprise an area of 0.2 ha each on the average such tasks constituted 1.3% of the total area cleared (by the civilian operators). For the 2004 Work Plan 14 tasks have been identified.

We can safely assume that a well considered for clearance will be a much needed well, serving a community of perhaps as many as 15 families. When this near by source of water supply has been blocked, one family member, that is to say 15 persons from the community, may have to travel as much as 5 km, 70% of them using bicycle and 30% motorbike for the transport. At the source this person may have to wait 1 hour on the average in order to fill up the container for transport back. It is assumed here that water is fetched by an adult person. One trip every day is needed, but limited to the dry season only, that is to say for 26 weeks a year.

Persons engaged	15	
Number of trips a day	1	
Days a week	7	
Weeks a year	26	
Distance to source km	5	
Trips to and from	2	
Waiting at source, hours	1	
	Bicycle	Motorbike
Mode of travelling	70 %	30 %
Travel speed km/hour	5	15
Duration one trip, hours	3	1,7
Value of travel time US$/day	0,23	0,23
Vehicle operating cost US$/km	0,001	0,07
Time cost annually US$	165	39
Travel cost annually US$	19	573

Table 6.9: Water supply and cost of water transport.

Table 6.9 provides the input data for the analysis of benefits related to reopened access to a water supply source in the vicinity. The benefits are calculated as the reduced amount of transport cost and travel time needed in comparison with the collection of water from more distant sources.

	Annual	Net present value over 20 years
Benefits from clearance of wells, 1000 US$	0.8	6.8

Table 6.10: Benefits from clearance of wells, 1000 US$ annually and net present value over 20 years.

As Table 6.10 shows the benefits from clearing a well, estimated by the method described above, could amount to US$ 800 annually. Discounted over a 20 years' period the total benefits would thus constitute US$ 6,800, which is the figure to be compared with the clearance cost of wells.

Clearance of a well that on the average comprises a task of 0.2 ha, will cost about US$ 1,800 a piece, assuming unit costs of 0.9 US$ per m^2 or US$ 9,000 per ha.

It can therefore be concluded that the benefits from such clearance tasks are well capable of defending their costs, even in cases when the suspected areas are significantly larger. When the number of families using this source of water supply is higher than the 15 presumed here, the benefits will increase proportionally.

6.7 Historical and cultural sites

Cambodia's tourist sector is playing a crucial role and is considered a key to the country's development. Over the last decade it has made significant contributions to economic growth by attracting foreign investments, creating jobs, and generating income for the local people.

With Cambodia's enormous cultural and natural heritage, the policy will be geared towards cultural and eco-tourism.

There are many historical sites in Cambodia. The Angkor temple complex is a world's heritage site. Besides that actions are taken to develop other cultural and eco-tourist destinations such as the Kulen Mountain, Kos Ker temple, Preah Vihea temple, Ta Mok house in Anlong Veng, and Sambo Prey in the central zone. Preservation of the historical sites is a socio-cultural obligation, which can also generate revenues in foreign exchange, and the Cambodian government intends to use tourism as a strategy in its overall goal to relieve poverty.[71]

An important task of mine clearance was carried out in the south of the province of Siem Reap from 1992 on, to give access to the main historical and religious site in the Kingdom of Cambodia, the Angkor area. From 1993-2003 the clearance tasks related to temple areas there amounted to 1.1 km^2 in total.[72] The temple areas of Angkor comprise in total about 250 km^2.

Total receipts from tourist related activities were estimated to US$ 454 million in 2002, with an increase of 19.5% from the year before. In 2002 tourist receipts accounted for 11.4% of GDP. Average tourist expenditures in Cambodia were US$ 577 per person in 2002.[73]

The total number of foreign tourists to Angkor will in 2004 exceed 420,000.[74] Assuming that the above mentioned figure of US$ 577 reflects the gross spending per tourist rather than the contribution to the GNP, a more conservative estimate of US$ 200 per tourist per year will be applied, to account for the deduction of inputs from other sectors to the tourist industry.

This would nevertheless result in an annual income generation of US$ 320,000 from each of the 250 km^2 of temple areas in Angkor, on the assumption of 400,000 tourists per year. This amount is spent inside the country, but not necessarily entirely within the localities harbouring the temples. It is, however, assumed that the historic sites with the ancient temples constitute the main attraction for tourists into Cambodia.

Tourists at Angkor annually, 1000	400
Tourist contribution to GNP, US$ per visitor	200
Angkor temple areas km^2.	250
Annual revenues per km^2 temple area in Angkor, US$ 1000	320
Income generation compared with Angkor	50 %
Incomes per sq km from opening up other temple areas, US$ 1000	160
Additional attraction of tourists, annual number per km^2 of temple area.	800

Table 6.11: Tourists and tourist revenues from temple areas

On the other hand it can not be expected that the opening up of new areas will generate incomes to that extent. From a cautious optimism some 50% of that amount could perhaps be foreseen, which would still constitute an income of about US$ 160,000 annually from each new km^2 of temple area opened up. A total of 800 additional tourists would then be attracted annually per km^2 of temple area with renewed access.

[71] Council for Social Development (2002): National Poverty Reduction Strategy 2003-2005, chapter 4.2.3.
[72] Source: CMAC Demining Unit 6.
[73] National Institute of Statistics: Statistical Yearbook 2003, page 293.
[74] Source: Ministry of Tourism. January – October 2004: 418,000 foreign and 290,000 Cambodian tourists.

	Annually	Net present value over 20 years
Benefits from opening up 1 km^2 of temple area, 1000 US$	160	1362

Table 6.12: Benefits from clearance of temple areas, 1000 US$

The annual contribution to the GNP of US$ 160,000 can be discounted over 20 years resulting in a total net present value to the economy of US$ 1.36 million from opening up 1 km^2 of temple area for tourism. This figure can then be compared with the cost of clearance.

At a rate of US$ 0.9 per m^2 or US$ 900,000 per km^2 the clearance costs would end up well below the estimated future benefits of US$ 1.36 million, and clearance tasks in temple areas could come out with a considerable surplus.

Presumably there might not even be need for de-mining the entire temple premises. In the Angkor temple area of 250 km^2 about 1.1 km^2 of clearance tasks were identified (there is still much Uxo remaining). The clearance task could thus perhaps be reduced to 75% or maybe even 50% of the actual temple area opened up for visitors.

For a particular clearance task the assumptions applied here must be checked and adapted to local circumstances. Still it appears that the benefits from the tourist industry alone could very well be capable of defending the costs of clearance tasks related to temples.

6.8 Health stations

Access to health stations may be difficult in rural Cambodia, in the remote areas there are few available and people travel considerable distances. When some premises are mined, people from neighbouring villages may have difficulties with finding alternatives close by. It is thus assumed here that they may have to travel on the average 5 km longer to reach to the nearest location.

The travellers will consist of sick people needing transport, but also of people accompanying them, mothers with children for example. It is here assumed that a station closed because of mine contamination will generate need for extra travel for 15 persons a day, during 5 days a week, 50 weeks a year. The travel will be to and fro, that is to say 10 km in all. It is also assumed that 70% need motorized transport (motorbike), while the rest is using bicycle.

Benefits from clearance so that a health station can reopen include reduced travel costs and a valuation of the reduced travel time (see tables 6.7 and 6.9).

	Annually	Net present value over 20 years
Benefits from clearance of health stations, US$ 1000	2.0	16.7

Table 6.13: Benefits from clearance of health stations, 1000 US$ annually and net present value over 20 years.

Table 6.13 gives the annual benefits from clearance of health stations, and the net present value discounted over 20 years. This last figure can be compared to the actual cost of clearing

the contaminated area comprising the health station. Assuming that a health station on the average occupies an area of 1.2 ha and a clearance cost of US$ 9,000 per ha, it appears that clearance of health stations is well capable of defending its costs.

6.9 Other social and cultural infrastructure

Regarding administrative offices, pagodas etc, the relevant items on the benefit side will comprise the construction costs including the value of the terrain. Here the state of repair of the building on site must also be taken into account; there will perhaps be need for rehabilitation, which should be reflected in the value estimate. This value can then be compared directly with the cost of clearance.

7. Clearance techniques and costs

7.1 Approaches and techniques in use

The agencies currently involved in the mine action programme in Cambodia actually comprise the Cambodian Mine Action Centre (CMAC), the HALO Trust, the Mines Advisory Group (MAG), constituting the 3 civilian operators, and the Royal Cambodian Armed Forces. There is little standardization among the operators as of the approach to the tasks, the set-up of teams for the field work, techniques and types of equipment in use. This makes it difficult to compare efficiency and costs.

On the other hand, there might also be advantages to some degrees with letting the operators pursue their own approach and experiment with the best way of meeting technical and economic challenges. Competition among the operators is, however, limited, as there is no regular practice of putting larger clearance tasks out on tender. Each operator to a large extent benefits from its proper and regular sources for funding (see chapter 4.5).

Manual de-mining is the basic technique applied by all operators, this is also a slow technique and therefore costly. It can, however, be applied widely on almost all types of terrain.

Mine Detection Dogs (MDD) have been introduced by CMAC, at the outset with technical support from Sweden. The use of MDD is in particular appropriate in areas with high contents of fragmented metal, on hard ground, and in quality control. Dogs can also be used for technical survey and area reduction. CMAC actually disposes of 5 MDD teams which cleared an area of about 1.3 km^2 in 2003.[75]

In Cambodia the mechanical de-mining techniques consist of various types of machinery used to prepare the ground for manual or dog teams, largely through cutting the vegetation before de-mining. Operators claim large efficiency gains from using these brush-cutters on suitable terrain.

Operators have developed different approaches of involving local communities in mine-marking, Uxo disposal and mine risk education and reduction activities. The approach is vital especially as a way to cope with the growing Uxo accidents problem in the country.

One factor influencing clearance productivity to a high degree is the different practices among operators towards applying area reduction techniques before clearance operations start. This is a field where new approaches are being introduced to give more value for money, in the form of clearance of areas which really were infested. On the paper, however, it might in some cases reduce productivity, measured as costs per m^2 cleared for example.

Survey activities constitute an important task in mine action, both for marking and fencing off areas to avoid accidents, to reduce areas to be cleared and thereby the costs, but also to gather information about the type of area, soil type, content of metal etc. which can help determine the cost of clearance and the use and benefits from the area after clearance.

7.2 Clearance costs

Information about the costs of mine and Uxo clearance in Cambodia is of widely varying quality. Even the information about financing is lacking, since the amounts RCAF receives are largely unknown. Some operators receive considerable donations in kind, of equipment and technical assistance. These donations do not regularly appear as costs in the accounts.

[75] CMAC Annual Report 2003, page 30.

For the year 2003 CMAC presents an average cost of US$ 0.95 per m^2 cleared, underlining that this cost also includes a number of non-clearance activities.[76] RCAF consistently applies a rate of US$ 0.35 per m^2 in its calculations of de-mining costs.[77]

Based on its total project income and clearance rates HALO calculates its cost to US$ 0.68 per m^2 land cleared in 2004. This constitutes a 10% improvement from the year before.[78]

In Cambodia village de-mining continues, although technically it is illegal. In some cases, people hire a village de-miner to clear the land for them. *Landmine Monitor 2003* reported that in Banteay Meanchey the price for clearing one hectare was US$ 90 while in Battambang, the price rose from US$ 100 to 250 per ha in 2002 (US$ 0.025 per m^2).[79]

A recent study (Griffin and Keeley 2004) based on model calculations for Cambodia, has found costs per m^2 ranging from US$ 1.50 when only manual de-mining is used, to US$ 0.96 with the current mix of machines, dogs and manual de-mining teams. Using dogs to a larger extent could, in combination with other cost reduction measures reduce costs further to US$ 0.65 - 0.62 per m^2 land cleared.[80]

Analysis of cost estimates presented by operators to their clients reveals unit rates of about US$ 0.85 per m^2 after adding depreciation and 10% overhead costs.

A complete picture of the cost of clearance should comprise:

- Only those activities connected to the clearance of mines and Uxo (still training, survey, planning etc related to clearance should be regarded as integral parts).
- Free of charge inputs, grants of equipment, technical assistance, manpower, housing etc from donors or the government should be costed in a regular way.
- Input and use of all types of capital goods like equipment and machinery, should be costed on basis of regular annual depreciation rates.
- Appropriate maintenance costs on a sustainable basis must be included for all equipment.
- Overhead costs must be included also when they are financed separately.
- Techniques and methods in use must conform to international security standards.

The operators should be required to provide CMAA with better data on the cost of conducting different mine action activities. One way of relating costs to the types of area cleared and the different approaches and techniques used, could be to go via registration of the time used in hours for each individual clearance task (some operators already collect such data). Cost per hour for different types of teams and tasks will presumably be a much more stable and less controversial entity than the costs per m^2 cleared. This cost per hour can then through a second step be calculated into cost per m^2 after an analysis of what time it takes on the average to clear a certain type of area with a given technique. These figures may be expected to vary, being depending on a number of factors.

[76] CMAC Annual Report 2003, Executive Summary page v.
[77] Engineer Forces Command HQ Report: The result of mine and unexploded ordnance clearance 2004.
[78] The HALO Trust Cambodia: Annual Report 2004, page 6.
[79] Paterson and Vanna (2004): A Study of Capacity Development in Mine Action, Case Study of Cambodia (GICHD September 2004) page 34.
[80] Griffin and Keeley (December 2004): Joint Evaluation of Mine Action in Cambodia, Annex 2.2.

Some operators are in the process of developing their accounting procedures, which could result in better cost-estimates with more details on different types of areas, tasks and techniques which are largely non-existent now.

For the further analysis it will be assumed that the existing cost level for the clearance activities conducted under the mine action programme in Cambodia could be situated in the vicinity of US$ 0.90 per m^2, while there might be possibilities of efficiency gains resulting in a reduction towards about US$ 0.70 through use of dogs to a larger extent etc. A factor leading in the opposite direction, however, is that clearance may in the future more and more have to be conducted in the remote and difficult accessible regions of the country.

7.3 De-mining accidents

The number of de-mining accidents reported is actually at a level of about 10 a year. In 2003 CMAC reported incidents involving 7 de-miners, of which 2 were seriously wounded, the others slightly injured.[81] HALO reports of three accidents in 2004, two of them in minefields inflicting minor wounds on one person. The third one involved a de-mining supervisor who in disregard of direct instructions attempted to cut open an anti-tank mine. This led to his death.[82] CMVIS reports of 8 accidents during de-mining in 2003 and 4 in 2002. For earlier years de-mining is not a category in the CMVIS statistics.[83] On the other hand the CMVIS figures may include accidents both with the official operators and unofficial private clearance.

There is a question, however, to what extent accidents may go unreported. An initiative could be taken to establish a record also for the previous years, of accidents linked directly to de-mining and Uxo clearance with the certified de-mining operators.

[81] CMAC Annual Report 2003, page 71.
[82] HALO Trust Annual Report 2004, page 5.
[83] CMVIS National Census 2002-2003, page 21.

8. Evaluation of priorities

8.1 Assumptions and approach

The achievements of the Cambodian mine action programme will in this and the next chapters (8-9) be evaluated by applying standard cost benefit methodology. The effect on the two principal objectives of mine action, reducing the human loss and clearance for development will be measured in economic terms, with further conclusions on how and where the mine action programme can contribute to fulfil these goals in the most efficient way. The assessment of the human loss conducted in chapter 5 and the different types and tasks of min/Uxo clearance for development activities evaluated in chapters 6, together with the observations on current clearance costs in chapter 7, provide the main input to this analysis.

The analysis makes extensive use of the benefit cost ratio (BCR)[84] for the comparison of different clearance activities and tasks (on methodology see chapter 1.3). A positive BCR means that the benefits cover the costs, the break even point is 0, and with a negative BCR the economic benefits as calculated here do not suffice to justify the clearance costs. This needs not imply, however, that other than economic benefits are irrelevant; frequently there will be additional considerations to take into account.

Still, in many cases those other benefits may have a direct relation to the economic benefits as calculated here; to the number of mine/Uxo victims expected avoided in future years, and to the size and types of area that can be reclaimed for useful purposes. In such cases the actual *priority* indicated may still be relevant, even though the BCR might experience an upgrading in *magnitude* through the inclusion of other benefits, so that more clearance activities and tasks come out on the positive side. This could call for more resources to mine action, but nevertheless by withholding the main rank of priority.

The benefit side of the ratio will thus regularly comprise the two main components:

(1) Development effects; including production or revenue increase, improved access to infrastructure etc.

(2) Expected reduction of human loss.

The cost side has been assessed in two alternatives, a cost of US$ 0.90 or US$ 0.70 per m^2 of land cleared, as explained in chapter 7 (amounting to US$ 9,000 or 7,000 per ha).

8.2 Agricultural land

The evaluation of clearance tasks on agricultural land come out with rather low benefits compared to the costs. The agricultural output is generally moderate in Cambodia, even though an annual 2% increase in output has been included in the analysis, and it is presumed that the clearance of an area on the average can open up 30% more of formerly suspected land for productive use (see chapter 6.1).

[84] Benefits minus costs divided by costs, the factors being discounted to present value at a rate of 10%.

Provinces	Agricultural land			
	Production	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Battambang	40 %	60 %	-0.45	-0.29
Pursat	83 %	17 %	-0.54	-0.41
Siem Reap	75 %	25 %	-0.71	-0.63
Otdar Meanchey	62 %	38 %	-0.29	-0.09
Banteay Meanchey	38 %	62 %	-0.49	-0.35
Pailin	50 %	50 %	0.36	0.75
Kampong Thom	40 %	60 %	-0.32	-0.12
Kampong Cham	67 %	33 %	-0.20	0.03
Preah Vihear	52 %	48 %	-0.38	-0.20
Average/others	53 %	47 %	-0.38	-0.20

Table 8.1: Clearance of agricultural land – cost benefit analysis.

At the actual clearance cost of US$ 0.90 per m^2 only agricultural areas in Pailin come out on the positive side, benefits here surpass costs by 36%. In case the clearance costs could be lowered to US$ 0.70 per m^2, Kampong Cham would also join the positive side, while some other provinces are approaching break even.

Yet the main conclusion is not that clearance of agricultural areas is unprofitable. There is, however, a call for conscious prioritization, a planning process capable of identifying those areas and tasks that are of highest importance to the local communities, for agricultural production and also towards reducing prevailing high risks of mine/Uxo accidents. This seems to concern provinces like Siem Reap and Pursat in particular.

Cost efficient methods in clearance and improved area reduction techniques are also highly important issues. This will be imperative for the conception of strategies concerning all types of suspected areas, providing that Cambodia is aiming at fulfilment of its obligations towards the Ottawa Convention, and in view of a possible shift of interest in the donor community away from financing mine action.

The distribution of benefits between production gains and reduced human loss, reflect the observed differences in output among the individual provinces regarding agricultural production (chapter 6.1), and the efficiency of area clearance as a means towards reducing accident risks and number of casualties (chapter 5).

8.3 Irrigation systems

For irrigation canals it has been presumed that clearance of the canal area will benefit a much wider extent of agricultural land. One km of irrigation canals could thus allow dry-season irrigation of 1 km^2 agricultural land, while 1 km of canal may constitute a clearance task of only 4 ha. The benefits to the farmers materialise from the possibility of dry season crops on the land (see chapter 6.2). From the statistics it appears that some provinces in Cambodia offer few possibilities for dry season replanting, and these have not been included here.

Provinces	Irrigation canals			
	Production	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Battambang	95 %	5 %	5.4	7.3
Pursat	98 %	2 %	3.5	4.7
Siem Reap	99 %	1 %	4.1	5.5
Banteay Meanchey	94 %	6 %	4.4	5.9
Pailin	84 %	16 %	3.4	4.6
Kampong Thom	93 %	7 %	4.6	6.2
Kampong Cham	96 %	4 %	6.0	8.1
Average/others	95 %	5 %	4.6	6.1

Table 8.2: Clearance of irrigation canals – cost benefit analysis.

Table 8.2 demonstrates that benefits accruing from the use of irrigation canals have no difficulties with justifying the clearance costs. The main factor is the assumption that renewed access to irrigation opens up for dry season cultivation of a much larger area than the one that needs to be cleared. Benefits are in the range of over 300% to 800% larger than the costs, and clearance could be undertaken even in cases when costs are found to be substantially higher than the alternatives applied in table 8.2.

The variations among regions reflect mainly the experienced differences in dry season output of crops and the price of paddy. The gains related to avoided human loss constitute a less important percentage, but this is only due to the fact that the cleared areas are small compared to the extent of the agricultural area that can be reclaimed for dry-season cultivation. The expected casualty reduction per unit of area cleared is thus the same as in table 8.1.

8.4 Wells and water supply

The benefits from clearance of wells are based on the savings experienced by the local community from renewed access to water supply in the vicinity, that is to say the reduced travelling cost to distant sources. The savings comprise reduced travel expenses and time loss for those family members occupied with fetching water (chapter 6.6).

Provinces	Clearance of wells			
	Improved access	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Battambang	92 %	8 %	3.1	4.3
Pursat	98 %	2 %	2.8	3.9
Siem Reap	98 %	2 %	2.8	3.9
Otdar Meanchey	93 %	7 %	3.0	4.2
Banteay Meanchey	92 %	8 %	3.1	4.2
Pailin	85 %	15 %	3.4	4.7
Kampong Thom	90 %	10 %	3.2	4.4
Kampong Cham	94 %	6 %	3.0	4.2
Preah Vihear	93 %	7 %	3.1	4.2
Average/others	93 %	7 %	3.0	4.2

Table 8.3: Clearance of wells – cost benefit analysis.

As shown in table 8.3 the benefits from clearance of wells for local water supply has no difficulties with defending the costs. Benefits are in the range of 280% to 470% larger than the costs, which means that clearance could also be undertake in cases when the costs for some reason were substantially higher than the two alternatives in table 8.3.

The contribution towards reduced human loss makes up a smaller percentage of the benefits. This is, however, only a consequence of the limited areas that need to be cleared (0.2 ha on the average) in order to gain renewed access to the water supply. The casualty reduction per unit of area cleared is thus the same as previously applied in the analysis. The reduced human loss is on the other hand the only factor that causes variations among provinces here. The user benefits from renewed access to wells are presumed identical for all provinces in this analysis.

8.5 Roads and bridges

The benefits from clearance of roads and bridges materialise as a consequence of renewed access to shorter alternative routes between origin and destination for the road traffic. It has been assumed that the travelling distance on the average can be reduced with 1 km after de-mining. The benefits from the improved access comprise both reduced vehicle operating costs and saved travel time for people using the roads (see chapter 6.4).

Provinces	Clearance of roads and bridges			
	Improved access	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Battambang	90 %	10 %	2.3	3.3
Pursat	97 %	3 %	2.1	3.0
Siem Reap	98 %	2 %	2.1	3.0
Otdar Meanchey	92 %	8 %	2.3	3.2
Banteay Meanchey	91 %	9 %	2.3	3.3
Pailin	82 %	18 %	2.7	3.7
Kampong Thom	88 %	12 %	2.4	3.4
Kampong Cham	92 %	8 %	2.3	3.2
Preah Vihear	91 %	9 %	2.3	3.3
Average/others	91 %	9 %	2.3	3.2

Table 8.4: Clearance of roads and bridges – cost benefit analysis.

Table 8.4 shows that the benefits from renewed access to direct routes can be considerably larger that the costs generally required for the clearance of roads and bridges. The benefits are in the range of 200% to 370% larger than the costs. Clearance of roads and bridges could thus be undertaken also in cases of a substantially higher cost levels.

The moderate contribution from reduced human loss reflects the elevated benefits from the improved access to direct routes. The casualty reduction per unit of area cleared is thus the same as previously applied in the analysis. The reduced human loss is moreover the only factor that causes variations among provinces. The road users' benefits from access to more direct routes are presumed identical for all the provinces in this analysis.

8.6 School premises

The expected benefits from clearance of school premises are based on an approach similar to wells and roads, namely the saved travel cost and travel time for the schoolchildren. When the village school premises are contaminated with mines the pupils will presumably have to travel a longer distance to some neighbouring school where it is possible to crowd in. The benefits comprise reduced travelling expenses in the form of vehicle operating costs and saved travel time (see chapter 6.5).

Provinces	Clearance of schools			
	Improved access	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Battambang	83 %	17 %	0.97	1.54
Pursat	95 %	5 %	0.72	1.21
Siem Reap	96 %	4 %	0.71	1.20
Otdar Meanchey	86 %	14 %	0.91	1.45
Banteay Meanchey	84 %	16 %	0.95	1.51
Pailin	71 %	29 %	1.32	1.99
Kampong Thom	80 %	20 %	1.05	1.63
Kampong Cham	86 %	14 %	0.90	1.45
Preah Vihear	85 %	15 %	0.94	1.49
Average/others	85 %	15 %	0.92	1.47

Table 8.5: Clearance of school premises – cost benefit analysis.

The benefits from clearance of school premises are to a large extent capable of defending their costs. The benefits from renewed access to near by facilities can exceed costs on their own account, but the fact that the mined school area in addition represents a risk of accidents constitutes an important additional factor to take into account. The difference among provinces in table 8.5 reflects this contribution to reduced human loss. Benefits could be from about 70% to almost 200% larger than the costs.

8.7 Historical sites and temples

The principal benefits from clearance of historical sites and temple areas in Cambodia will be the prospects of revenues from the expanding tourist industry. Revenues caused by the opening up of new areas have been estimated on basis of today's earnings from similar places (Angkor), with a cautious optimism as of the future prospects for the development of new areas (see chapter 6.7).

	Tourist revenues	Human loss	Benefit Cost Ratio	
	Per cent of benefits		US$ 0.90	US$ 0.70
Clearance of 100% of area	85 %	15 %	0,79	1,30
Clearance of 75% of area	88 %	12 %	1,29	1,95

Table 8.6: Clearance of historical sites and temples – cost benefit analysis.

Still, as shown in table 8.6, the benefits from clearance of historical sites and temple areas have generally no difficulties with defending the costs. The tourist revenues alone would suffice, but the reduced human loss connected with elimination of the accidents risk when mined areas are cleared, will also be a counting factor.

Net benefits increase with the reduction of clearance costs per m^2, but such tasks could in general also support high costs if necessary. In some cases the suspected area can be reduced in advance, so that more than those areas which need clearance can (safely) be opened up for visitors. In table 8.6 an alternative of 75% clearance is assumed. This could contribute to increase the net benefits and thus the BCR significantly.

8.8 Health stations

As with other rural infrastructure (roads, schools, and wells) mine clearance with renewed access to health stations can be justified by the reduced travel time and travel costs for the villagers that used to attend this particular station. It is here assumed that alternative facilities are located at a distance that requires an additional travel of 5 km each way (see chapter 6.8).

	Improved access	Human loss	Benefit Cost Ratio	
Number of clients	Per cent of benefits		US$ 0.90	US$ 0.70
15 persons a day	85 %	15 %	0.82	1.35
20 persons a day	88 %	12 %	1.34	2.01

Table 8.7: Clearance of health stations – cost benefit analysis.

From table 8.7 it appears that the benefits from renewed access to health stations surpass to a large extent the cost of clearing the premises. Both cost alternatives thus come out with considerable net surpluses. The benefits will increase proportionally with the number of clients, that is to say the persons benefiting from a shorter distance to this important facility.

The user benefits from improved access constitute the main parts of the benefits, simply because they are extensive compared to the area that needs clearance (one health station= 1.2 ha).

8.9 Conclusions

The main conclusions from the cost benefit analysis is that clearance providing renewed access to important rural infrastructure generally is capable of generating the largest gains compared with each invested US$. Roads, water supply, schools and health stations are excellent candidates in a development perspective, and such clearance tasks should be given priority as far as benefits in economic terms are concerned.

Clearance of historical sites and temples with the aim of attracting tourists should also be considered for priority. The potential here will depend on the accessibility and on other infrastructure for receiving the visitors in the vicinity.

In the agricultural sector a high priority should be given to the reopening of irrigation systems permitting dry season cultivation of arable land. Benefits could here be extensive and have important consequences for the rural economy and for food production.

For agricultural land in general it seems less evident that large-scale clearance programmes can be capable of generating economic benefits in a convincing degree. Clearance tasks should here be subject to a more thorough selection process in order to determine the priority.

Clearance for casualty reduction also needs to be well targeted in most cases and locations in order to have the desired effect. The selection will further be dependent on the possibility of an appropriate identification of those parts of the extensive mined areas in the country that are generating the bulk of the mine/Uxo accidents, representing an imminent danger to the people now and in future years with expected population movements etc. In spite of the excellent statistics on mine/Uxo casualties and incidents in Cambodia, there are lacking elements in the analysis that could help direct the clearance activity towards the most risky locations.

9. Evaluation of the Mine Clearance Programme

An evaluation has been made of the Cambodian mine clearance programme for a recent year. The information about cleared areas with distribution on provinces etc has been fetched from the 2004 Work Plan, while the distribution of clearance activities on sectors and types of area is related to the latest available information, mostly for the year 2003. An area of 29 km^2 was planned cleared in the year 2004.

Clearance cost per sq m	US$ 0.90	US$ 0.70
Cost Benefit Ratio	0.38	0.78
Internal Rate of Return	14 %	19 %
	Development	Human loss
Benefits	80 %	20 %

Table 9.1: Appraisal of the Cambodian mine clearance programme 2004.

The analysis shows that mine clearance is contributing substantial values to the country and the economy in general. The benefit cost ratio (BCR) is 0.38, implying that benefits in general are 38% higher than the costs, on basis of a clearance cost rate of US$ 0.9 per m^2. The internal rate of return will on the same assumptions be 14%. The benefits are distributed with 80% on clearance for development and 20% on the reduced human loss.

	Benefits US$ 1000	% of benefits	% of area
Agricultural land	10 344	28 %	65 %
Irrigation canals	3 448	9 %	2 %
Roads, bridges	16 669	45 %	19 %
Wells	1 392	4 %	1 %
Schools	2 270	6 %	4 %
Health centres	171	0.5 %	0.4 %
Temple areas	238	0.7 %	0.6 %
Other buildings etc.	2 343	6%	6 %
Total	36 875	100 %	100 %

Table 9.2: Distribution of benefits from the mine clearance programme 2004.

The benefits from the clearance programme 2004 amount to about US$ 37 million in total. Roads and bridges make up the largest parts of the benefits with 45%, even though the clearance tasks under this sector only comprise 19% of the total area cleared. Smaller size clearance tasks related to irrigation canals also contribute considerably. For agricultural land the situation is inverse, it constitutes as much as 65% of the cleared area while contributing 28% of the benefits.

It is clear that the programme net benefits in economic terms could be enhanced by diverting more of the clearance activity towards rural infrastructure like roads, water supply, schools etc, and also to sites attracting tourism. The agricultural sector could improve its contribution by active identification of tasks comprising irrigation components. Future benefits from the programme could be increased significantly through a reduction in clearance costs, utilisation of mine dogs to a larger degree for example, lowering the costs to US$ 0.7 per m^2. Benefits could then increase to a level 78% higher than the costs, equivalent to an internal rate of return of 19% (table 9.1).

	Benefits US$ 1000	Cost US$ 1000	Distribution of benefits	Benefit-cost ratio (BCR)	Benefits	
					Human loss	Development
Battambang	9146	6292	25 %	0,45	23 %	77 %
Pursat	3829	3060	10 %	0,25	6 %	94 %
Siem Reap	1332	1070	4 %	0,24	7 %	93 %
Otdar Meanchey	7210	5312	20 %	0,36	19 %	81 %
Banteay Meanchey	6305	4580	17 %	0,38	23 %	77 %
Pailin	1546	742	4 %	1,08	33 %	67 %
Kampong Thom	1208	752	3 %	0,61	26 %	74 %
Kampong Cham	320	140	1 %	1,28	13 %	87 %
Preah Vihear	5991	4726	16 %	0,27	23 %	77 %
Total	36886	26673	100 %	0,38	20 %	80 %

Table 9.3: Clearance programme 2004, distribution of benefits and clearance cost on province

Regarding the distribution of benefits and clearance costs on province the main conclusions are as follows:

- Benefits cover clearance costs in all provinces.
- The 4 provinces of Battambang, Odtar Meanchey, Banteay Meanchey and Preah Vihear collect the bulk (78%) of the benefits from the 2004 clearance programme.
- The benefit-cost ratio (BCR) is, however, highest in Kampong Cham and Pailin.
- The main part of the benefits comes from gains related to economic development. Still the reduced human loss is an essential factor, contributing to increase the programme benefits particularly in Pailin.

10. Poverty Reduction and Millennium Development Goals

10.1 Assumptions

The mine action programme is actively contributing to the socio-economic development of the country, and in particular to the achievement of goals related to the poverty reduction strategy and the Millennium Development Goals (MDG). Specific problems with the fulfilment of MDG 9: "De-mining, Uxo and Victim Assistance" have been discussed previously in the report, with the assessment of the programme achievements (chapter 4.3) among others. This chapter will therefore concentrate on the impact of the mine action programme in other areas related to poverty reduction and MDGs.

The analysis is based on clearance statistics for the period 1992-2003 broken down on provinces. This statistics is, however, incomplete and no information has been obtained from RCAF.[85] Still this information gives presumably the best available distribution of the amount of areas cleared during the period 1992-2003 in per cent on each province. The total amount of areas cleared, about 250 km^2, has thus been distributed accordingly.

Regarding the type of areas cleared, the analysis has to rely on information from recent years, mainly 2003 (as of figure 4.2), since information of this aspect is scarce for the preceding years. There is also little information about the type of areas cleared broken down on province level. The same pro rata distribution has therefore been used for all the provinces.

Information particularly scarce regarding RCAF's activities; still the total area cleared by RCAF has been included here. There is reason to believe, however, that more information would reveal a larger percentage of road clearance by RCAF than is the case for the other agencies.

10.2 Increased food production

Constituting 65% of the cleared areas in general, it is found that over 160 km^2 of agricultural land has been cleared by the Cambodian mine action programme during the period 1992-2003.[86] The largest share of this land is found in the provinces Banteay Meanchey, Battambang and Siem Reap, reflecting the fact that the largest part of the clearance activities has taken place in those provinces over the period considered.

Presuming that these areas are taken into use for paddy-growing, they could yield a net amount of over 20,000 tonnes of paddy at disposal for consumption (table 10.1). The assumptions of net yield in tonnes per ha etc are then the same as in table 6.1.

Additionally a total of over 140 km of irrigation canals have been cleared in the period. One km of irrigation canals could supposedly feed 1 km^2 of arable land with water, making cultivation of that land possible also in the dry season, a total of two paddy crops a year (see chapter 6.2). This additional dry season crop could boost rice production even more, presumably with over 30,000 tonnes in total in the principal mine and Uxo-infested provinces.

The increase in paddy production could thus amount to over 50,000 tonnes on a yearly basis in total for these provinces compared to the pre-clearance levels (before 1992). This

[85] Some problems with this statistics are discussed in chapter 4.3.
[86] Comprising land for agriculture and resettlement in the clearance statistics and figure 4.2.

production has been made possible on reclaimed agricultural land and through renewed access to irrigation canals.

	Agricultural land cleared ha	Irrigation canals km	Annual yield tonnes	Increase in production per cent	Families resettled 1000
Banteay Meanchey	4 562	40.7	15 832	8 %	45.6
Battambang	3 902	34.8	16 132	6 %	39.0
Kampong Cham	499	4.4	2 982	1 %	5.0
Kampong Speu	797	7.1	2 938	3 %	8.0
Kampong Thom	880	7.8	3 515	2 %	8.8
Kampot	795	7.1	3 005	2 %	7.9
Pailin	354	3.2	1 305	100 %	3.5
Kep	367	3.3	402	13 %	3.7
Odtar Meanchey	1 464	13.0	1 375	5 %	14.6
Preah Vihear	268	2.4	350	1 %	2.7
Pursat	371	3.3	1 572	1 %	3.7
Siem Reap	2 158	19.2	7 465	4 %	21.6
Total	16 416	146.4	56 874	3 %	164.2

Table 10.1: Effects on annual agricultural production volume from clearance during the programme period 1992-2003.

Table 10.1 distributes the effect on agricultural production on provinces. In general there is a 3% growth in paddy production which can be directly related to clearance under the mine action programme.

In some areas, however, the effect could be stronger. In the small province of Pailin about half of the area at disposal for paddy cultivation today (2002-03) has been subject to mine/Uxo clearance, according to the analysis here. With an addition of 3.2 km of irrigation canals cleared, it seems that large parts of the agricultural areas now at disposal in the province could have been affected by the mine clearance programme.[87] Kep is another small province where mine action could have had decisive impacts on the availability of arable land.

In the larger mine-infested provinces like Banteay Meanchey, Battambang and Odtar Meanchey, the contribution from mine action towards increase in food production could have been between 8% and 5%, which is still significant.

Clearance of areas that can be reclaimed for agricultural production could thus have strong impacts for MDG 1- Overall target 2, concerned with reducing the proportion of people suffering from hunger.

With the establishment of a transparent and equitable system for redistribution of the reclaimed land, which is a main goal under the mine action programme, the clearance of areas for resettlement will in general also be important for MDG 7- Overall target 16, to improve the access to land security.

The plot size needed for a family may be about 2 ha, but in most cases only parts of it will be mine/Uxo contaminated. Clearance of about 1000 m^2 may thus allow a family to settle and reclaim the larger area needed to subsist. On this assumption the clearance programme could have benefited over 160,000 families over the period 1992-2003, or more than 13,000 on the

[87] The previous reservations are still valid, however; the information of agricultural areas and irrigation canals cleared in each province are calculated figures, and not based on detailed statistics.

average each year (varying according to the annual amount of clearance activity). The geographical distribution is given in table 10.1, with the provinces of Banteay Meanchey, Battambang and Siem Reap as the main beneficiaries.

10.3 Rural transport

The existence of an extensive rural roads network is an important element in the food security strategy. The road network can provide efficient transport of produce out of regions with surpluses and into regions exposed to bad harvests and drought, thus encouraging the domestic trade in foodstuffs i.a.

In general the access to roads is vital for development of the rural areas, for poverty reduction and access to social services in general. The much needed expansion of the Cambodian agricultural sector for example is depending on access to transport.

Clearance of rural roads has been a main component in mine action. It is estimated that a total of over 1000 km of roads have been cleared during the programme period 1992-2003. Frequently there will, however, be significant needs for rehabilitation, so as a rule the clearance activities constitute integral parts of rural roads programmes.

There is actually a gazetted network of 4,700 km of rural roads in Cambodia, while ungazetted roads and tracks might comprise as much as 28,000 km. Under the cooperation programme financed by Germany (TRIP), about 1,600 km have been rehabilitated.

	Roads km
Banteay Mean Chey	332
Battambang	284
Kampong Cham	36
Kampong Speu	58
Kampong Thom	64
Kampot	58
Pailin	26
Kep	27
Odtar Meanchey	106
Preah Vihear	20
Pursat	27
Total	1037

Table 10.2: Clearance of roads under the mine action programme 1992-2003.

10.4 Water supply, schools and health stations.

De-mining school premises can contribute to fulfilling MDG 2- Overall target 3, aiming at improving the education system so that more children can be able to complete school. It is estimated that a total of over 800 schools have been cleared of mines/Uxo under the mine action programme 1992-2003.

Mine clearance is also frequently required to provide access to rural health stations, which are much needed in the fight against the spread of diseases like HIV/AIDS and malaria (MDG 6) and to reduce child mortality (MDG 4) and maternal mortality (MGD 5). It is estimated that about 60 health stations have been cleared under the mine action programme.

Clearance of water supply systems and rural wells could have a direct impact on MDG 7-Overall target 14, addressing the problem of improved access to safe drinking water. As much as 1400 wells and ponds could have been cleared in the course of the mine action programme 1992-2003.

Clearance of rural roads will frequently constitute an important supplement as a prerequisite to gain access to other rural infrastructure and social services.

	Wells	Schools	Health stations
Banteay Mean Chey	450	258	21
Battambang	385	221	18
Kampong Cham	49	28	2
Kampong Speu	79	45	4
Kampong Thom	87	50	4
Kampot	78	45	4
Pailin	35	20	2
Kep	36	21	2
Odtar Meanchey	144	83	7
Preah Vihear	26	15	1
Pursat	37	21	2
Total	1407	806	64

Table 10.3: Clearance of wells, schools and health stations under the mine action programme 1992-2003.

11. Main Conclusions

Mine action is contributing substantial values to the Cambodian economy and the country in general. Analysis of the 2004 clearance programme comes out with a benefit cost ratio (BCR) of 0.38, implying that benefits are in general 38% higher than the costs, on basis of an average clearance cost rate of US$ 0.9 per m^2. The internal rate of return will on the same assumptions be 14%.

The benefits amount to about US$ 37 million in total, distributed with 80% on clearance for development and 20% on reduced human loss. Roads and bridges make up the largest parts with 45%, even though such clearance tasks only comprise 19% of the total area cleared. Smaller size tasks related to irrigation canals also contribute considerably. For agricultural land the situation is inverse, it constitutes as much as 65% of the cleared area while making up 28% of the benefits. In total about 29 km^2 of mined areas were planned cleared in 2004.

The benefits from renewed access to more direct road links can be considerably larger that the costs required for clearance. Clearance of roads and bridges could thus be undertaken also in cases of relatively high cost levels. The benefits from renewed access to wells for local water supply, schools and health stations have likewise few difficulties with justifying clearance, on basis of the reduced travel time and travel costs for the users and the pupils.

These are excellent candidates in a development perspective, and such tasks should be given priority as far as benefits in economic terms are concerned. It is evident that the programme benefits could be enhanced by diverting more of the clearance activity towards rural infrastructure like roads, water supply, schools etc, and also to sites attracting tourism.

The output per ha of arable land is on the average rather moderate in Cambodia. Yet the main conclusion is not that clearance of agricultural areas is unprofitable. There is, however, a call for conscious prioritization, a planning process capable of identifying those areas and tasks that are of highest importance to the local communities.

In the agricultural sector high priority should be given to the reopening of irrigation systems permitting dry season cultivation of arable land. Benefits could here be extensive and have important consequences for the rural economy and for food production.

Clearance for casualty reduction also needs to be well targeted in most cases and locations in order to have the desired effect. Improved assessments could be made of which parts of the extensive mined area in the country that are generating the bulk of the mine/Uxo accidents, representing a danger to the people now and in future years with expected population movements etc. In spite of the excellent statistics on mine/Uxo casualties and incidents in Cambodia, there are lacking elements in the analysis that could help direct the clearance activity towards the most risky locations.

Benefits cover clearance costs in all provinces. The 4 provinces of Battambang, Odtar Meanchey, Banteay Meanchey and Preah Vihear collect the bulk (78%) of the benefits from the 2004 clearance programme. The benefit-cost ratio (BCR) is, however, highest in Kampong Cham and Pailin. The main part of the benefits comes from gains related to economic development. Still the reduced human loss is an essential factor, contributing to increase the benefits from land clearance particularly in Pailin.

Mine action's contribution in the years 1992-2003 to increase the country's paddy production could amount to over 50,000 tonnes annually. This production increase has been made possible on reclaimed agricultural land and through renewed access to irrigation canals. This

constitutes in general a 3% growth in paddy production in the mine action regions, but could be even more important for food security in provinces like Pailin, Kep, Banteay Meanchey and Battambang.

A transparent and equitable system for redistribution of the reclaimed land is an important goal under the mine action programme. The cleared areas may have provided land and contributed to improve land security for about 160,000 families over the period 1992-2003, that is to say for over 13,000 on the average each year.

Clearance of water supply systems and rural wells has improved the access to safe drinking water in rural areas. An estimated 1400 wells and ponds have been cleared in the course of the mine action programme 1992-2003.

De-mining school premises contributes to improve the education system so that more children are able to complete school. Mine clearance is also frequently required to provide access to rural health stations, which are much needed in the fight against spread of diseases and to reduce child and maternal mortality. It is estimated that about 60 health stations have been cleared under the mine action programme.

The CMAA Socio-economic Cluster should in particular have a responsibility with following up the cost-benefit analysis.

There are indications that landmine damage to domestic animals might constitute a significant economic loss. This could call for an improved reporting system, if possible through CMVIS.

The extent of the mine/Uxo infested area in Cambodia is disputed; in particular what parts of it should be given priority for clearance. It is strongly recommended to revise the estimates of the contaminated area.

The CMAA database on cleared areas needs to be consolidated, so that it can provide official figures for clearance on location (province, district), types of areas, techniques etc for the individual years since the start of the mine action programme. As of today this information exists on different files which can be incomplete and inconsistent.

The operators should be required to provide better data on the cost of conducting mine action activities. Some operators are in the process of developing their accounting procedures, which could result in better cost-estimates with more details on different types of areas, tasks and techniques, information which to a large degree is non-existent now. As a first approach more information about the clearance time (in hours) of different types of tasks and areas could be demanded.

A library or Information and Documentation Centre should be established at CMAA to secure the institutional memory, comprising publications and reports issued by the programme and its service providers as well as literature related to mine action in general. Documents should be available in hard copies and/or in electronic format on computers and compact discs to facilitate copying and dissemination. Fire-protected and waterproof storing conditions should be provided.

Annex 1: Planning tools for mine action

A 1: Objective

The objective of this Annex 1 is to devise some straightforward methods, based on cost-benefit analysis, to be applied as instruments for assessing socio-economic and poverty reduction impacts of future mine clearance operations. The approach will be largely identical with the analysis presented in the previous chapters of this report, but with modifications making it simple and flexible, not requiring large analytical efforts.

A 2: First step

As a first step the data presented in chapter 8 of this report should be fully utilised. The tables 8.1 to 8.7 display the benefit-cost ratio (BCR) for presumably typical clearance tasks related to standard areas of intervention like:

- Agricultural land (8.2)
- Irrigation systems (8.3)
- Wells and water supply (8.4).
- Roads and bridges (8.5)
- School premises (8.6)
- Historical sites and temples (8.7)
- Health stations (8.8)

The BCR calculations there are also broken down on the provinces of most importance for the mine action programme today.

This information could be applied as a first step without any modifications, also in the analysis of new cases. On basis of knowledge about the use of the cleared area and the province in which it is located, the BCR of the new clearance task proposed could be read directly from those tables.

A 3: Second step

A second step will be to modify the input data so that the analysis can be made representative and reflect in a better way the situation for which it is to be applied. No elements are in principal fixed in this methodology, but this second step consists of devising some simplified ways of modelling the main elements of the analysis, without having to go too far into the spreadsheet details that form the ultimate basis of this report. This second step approach will thus concentrate on providing the analyst with an opportunity to modify the main cost and benefit elements of the BCR.

$$\text{Benefit-Cost Ratio (BCR):} \quad \frac{\text{Benefit} - \text{Cost}}{\text{Cost}}$$

Clearance costs

The assumptions behind the cost calculation are in this analysis very simple (see chapter 7). The range of cost alternatives vary between US$ 0.9 per m^2 (US$ 9,000 per ha or US$ 0.9 million per km^2) as of today's average cost, to a possible level of US$ 0.7 per m^2, in case more dog-clearance could be an alternative.

For the analysis of future clearance tasks, information should be obtained from the operators or estimated in other ways as appropriate from case to case. When data is scarce a sensitivity analysis in two or more alternatives could be performed.

Reduced human loss

The evaluation of the benefits from reduced human loss (chapter 5) is rather complex and based on a number of assumptions about the value of productive life time, medical costs, the characteristics of a typical mine victim, age, types of injury etc. The combined effect of these different factors has been evaluated in economic terms, and the result presented as the economic loss related to an average mine/Uxo casualty.

As a first step it is assumed that a mined area of 1 km^2 can be expected to claim one victim every year. The costs in economic terms related to this loss are given in table A1 as US$ 164,000 (for further reference see chapter 5 in the report).

Table A1: Cost benefit calculations related to the human loss:

(1): Economic loss for an average casualty, one victim every year over 20 years, 1000 US$:	164
(2): Area to be cleared or suspected area:	1 ^{km2}.
(3): Number of victims per unit of mined area:	1 victim per km^2.
(4): Economic growth:	3.5%

This basic figure of US$ 164,000 can then be modified in the following ways:

- When the area to be cleared is different from 1 km^2, the economic loss (1) will have to be multiplied with the appropriate relative size of minefield. A mined area of 2 km^2 is thus expected to cause the double loss, that is to say US$ 328,000.
- The expected number of victims may be different from 1 per year per km^2. In the cost benefit analysis the number of victims varied on province (from 0.4 to 4.7 per year, see table 5.1). The economic loss (1) in table A1 will therefore have to be multiplied with the appropriate figure for the expected number of victims, 2 casualties a year will entail the double loss, 1.5 a 50% larger loss etc.
- In the previous analysis (chapter 5.2) an economic growth of 3.5% was assumed for the first 10 years and 2.5% afterwards. The economic loss (1) in table A1 should accordingly be updated, from the year 2006 and onwards according to the development of the Cambodian GNP per capita.

On basis of these possibilities for modifications new and different estimates of the avoided human loss can be worked out as appropriate for the case under consideration, reflecting the available information on local conditions etc.

Agricultural land

The valuation of cleared agricultural land is based on the assumption that it can be used for paddy production and for raising livestock for own consumption or sale (see chapter 6.1). The main variables in these calculations are factors like the production yield in tonnes per ha, the farm-gate price of paddy, the number of animals raised or sold per year (pigs and poultry) and the sales price for these animals.

A standard case can be constructed, leaving a number of factors open for adaptation to local circumstances from case to case:

Table A2: Cost-benefit calculations related to agricultural land.

Assumptions:			Value 1000 US$
(1): Paddy growing	Yield: 1 tonne per ha	Price: 100 US$/tonne	75
(2): Pigs raising	1 pig per ha land	Price: US$ 50 each	54
(3): Poultry	10 per ha of land	Price: US$ 2 a piece	21
(4): Possibility for dry season crops			
(5) Total revenues from 1 km^2 of agricultural land:			SUM

In table A2 the net future revenues expected from paddy growing on 1 km^2 of land amount to a value of US$ 75,000 based on the assumption of a yield of 1 tonne per ha and a price of 100 US$ per tonne. When the conditions related with a specific clearance task are different, the value of 75,000 US$ should be modified accordingly. In case of a price per tonne of 110 US$ for example, the value will increase by 10% (to US$ 82,500), the same will be the case if the yield is expected to be 1.1 tonne per ha instead if 1 tonne.

The same approach can be used for modifying the contribution from the livestock business. If 1.5 pigs can be raised annually instead of 1 per ha land, the value should be increased by 50% from US$ 54,000 to US$ 81,000; price variations will have similar effects. In the analysis (table 6.1) differences were found in yield per ha and in the number of livestock raised per ha of agricultural land according to province.

The possibility for dry season crops on the cleared land should be investigated, in particular the percentage of the land that can normally be replanted. The information in table A2 on paddy growing (1) could then be used to add the value of an extra crop, specifying the appropriate yield in tonnes per ha replanted, and the price. Sometimes these will be different from the wet season crops (see table 6.1).

By adding the modified revenues in table A2 from (1) paddy growing, (2) pigs, (3) poultry and (4) an extra dry season crop which may be possible on (parts of) the land, the total amount of revenues from the use of 1 km^2 reclaimed agricultural land can be determined. When the extent of the land to be cleared is different from 1 km^2, the sum (5) must be altered as appropriate.

In some cases it may be found that additional formerly suspected areas can be reclaimed without clearance, by area reduction techniques etc. An extra percentage may then be added

to the benefits, without increasing the clearance costs (see chapter 6.1). This must, however, be investigated from case to case.

To the agricultural benefits from reclaimed land (table A2) will be added the benefits from the expected reduction of human loss on the same land (table A1). These two elements will form the benefit side in the benefit-cost ratio (BCR). The clearance costs must then be estimated. Finally the clearance task can be evaluated by calculating the BCR.

Irrigation canals

The benefits from clearance of irrigation canals are related to the extra output from the land which gains renewed access to irrigation as a direct cause of the clearance. It is assumed that this land can now produce dry season crops, and a main input to the analysis will therefore be the estimated value of that extra crop. These benefits will be identical with table A2 (1) paddy growing, while no changes are here presumably inflicted on the livestock business.

Table A3: Cost-benefit analysis of clearance in irrigation systems.

Assumptions:			Value 1000 US$
(1): Paddy growing	Yield: 1 tonne per ha	Price: 100 US$/tonne	75
(2): Total revenues from 1 km^2 of agricultural land:			SUM
(3): One km of irrigation canals will serve 1 km^2 of arable land.			
(4): One km of irrigation canals constitutes a clearance task of 4 ha.			

The value of the dry season paddy crop (1) must, however, be updated with appropriate estimates for the yield in tonne per ha, which may be higher than in the wet season (see table 6.1), and also for the farm gate price of paddy. This will result in an estimate of the total revenues from 1 km^2 of agricultural land (2).

Formerly in the cost benefit analysis it has been assumed that one km of irrigation canals can serve 1 km^2 of arable land with irrigation water for a dry season crop (3). This proportion can, however, vary from case to case. An independent appraisal should be made about the amount of land to be irrigated by the particular canal that is considered cleared, so that the revenue estimate (2) can be modified accordingly (an area of ½ km^2 will generate ½ of the revenues).

It was assumed (4) that one km of irrigation canals constitutes a clearance task of 4 ha. The canal is then cleared in 20 m wide lanes on both sides. This assumption is also open to modifications, which will affect the cost side of the BCR.

A special feature with irrigation canals is that the area which needs clearance and entails costs normally will be much smaller than the land which reaps the benefits. The potential for avoided human loss will, however, be related to the area which has been cleared. This benefit component should be added (see table A1).

The clearance task can now be evaluated by calculating the BCR.

Roads and bridges

In the analysis it was presumed that a kilometre of mined roads will cause diversion of traffic onto other links of double distance on the average (see chapter 6.4). The benefits from clearance of 1 km of mined roads will thus consist of the savings to road traffic and transport from travelling a 1 km shorter route.

This proportion may vary from case to case. The length of the alternative routes should therefore be assed independently to reflect local conditions and take into account the actual extra travel distances experienced by the road users.

Table A4: Cost benefit analysis of road clearance

Assumptions:	US$ 1000
(1): Benefits from clearance of 1 km of rural roads	108
(2): One km of mined roads will divert traffic onto routes of double distance.	
(3): Traffic level	
(4): A 1 km road link constitutes a clearance task of 4 ha.	

The additional transport costs when the road users have to travel one km extra is calculated to US$ 108,000 in table A4 (1). This is the amount that can be saved when the road opened after clearance shortens the travel distance with one km on the average. The relevant issue here will be the difference between the distance travelled before and after clearance of a particular road link. If this difference is larger than 1 km, say 1.5 km, the benefits (1) should be increased by 50%, and in case the difference is only 0.5 km the benefits will be ½ of US$ 108,000.

Another important element for determining the benefit side will be the traffic. This was estimated on basis of traffic counts in rural areas (table 6.4), comprising a daily traffic of:

- Ox-carts: 19.
- Bicycles: 13.
- Motorbikes: 297.
- Motor trailers: 26.
- Car/ pickups: 19.
- Trucks: 5.

This traffic level is reflected in the benefit estimate of US$ 108,000. Independent estimates should be made, however, and in case the road traffic in the particular case is found to be significantly higher or lower, the benefit sum should be amended accordingly. A traffic level which is generally 25% higher than the figures indicated above will thus generate 25% more benefits. Particular attention should be made to the level of motorised traffic, as this will have the largest impact on the benefits.

It was further assumed (4) that one km of road constitutes a clearance task of 4 ha. The road is then cleared in 20 m wide lanes on both sides. This is standard for clearance tasks ordered by ADB for instance. The total area to be cleared will then depend on the length of the mined road, which will determine the clearance costs. The area to be cleared will also form basis for an estimate of the benefits from the expected reduced human loss (table A2).

The state of repair of the road ought to be taken into account. Clearance tasks regularly form integral parts of rural roads rehabilitation programmes. Rehabilitation of rural roads may cost

between US$ 6,000 (upgrading) and US$ 12,000 (improved standard) per km, but the actual need must here be assessed from case to case.

The clearance task can then be evaluated by calculating the BCR.

Schools

The benefits from clearance of school premises were based on the assumption that the pupils will have to travel an extra distance of 5 km each way in order to reach an alternative location. The benefits from saving these travel costs after clearance are given in table A5 as US$ 18,000.

Table A5: Cost-benefit analysis of clearance of school premises.

Assumptions:	US$ 1000
(1): Benefits from clearance of school premises	18
(2): Extra travel distance 5 km each way every day.	
(3): Number of pupils travelling: 80	
(4): School areas constitute clearance tasks of 1.2 ha.	

The difference in distance between travelling to the reopened school compared with the alternatives used before clearance will here be the issue. In case this difference is calculated to more than 5 km, the benefits will be higher than US$ 18,000. An extra travel distance calculated to 10 km will here generate the double benefits.

Another factor that will influence the benefit side is the number of pupils at the school. Here it is assumed that 80 pupils will be travelling. With 60 pupils, or 25% less, the benefits from reopening the school will also be 25% less.

It was assumed that a school area constitutes a clearance task of 1.2 ha. This area might, however, vary from case to case. Clearance costs will depend on the extent of the area to be cleared. Possible repair costs should be taken into account, but not upgrading. The cleared area will also form basis for an estimate of the benefits from reduced human loss (table A2).

The project can then be evaluated by calculating the BCR. Here the two benefit components, reduced travel distance for the pupils and reduced human loss will be compared to the clearance costs.

Wells and water supply

The benefits from clearance of rural wells can also be related to the extra travel distance needed for the villagers to reach an alternative supply. Here it has been assumed that the extra distance to the nearest source could be 5 km longer on the average each way. Further it has been assumed that 15 persons are occupied with the daily fetching of water. The travel costs related to this extra distance for the 15 persons involved can then be saved after de-mining of the local well. These total benefits have been calculated to US$ 6,800 (see chapter 6.6).

Table A6: Cost-benefit analysis of water supply

Assumptions:	US$ 1000
(1): Benefits from clearance of wells	6.8
(2): Extra distance to nearest source: 5 km each way	
(3): Persons occupied with fetching water: 15	
(4): Wells constitute clearance tasks of 0.2 ha	

The benefit will depend on the extra distance travelled, which should be assessed independently in each case. A 25% larger difference in travel distance between the reopened local water supply and the alternatives used before clearance will increase the benefits with about 25%.

The size of the local community using the well, reflected in the number of persons engaged in fetching water will also be of importance. In case of a larger community with 30 persons travelling to fetch water, the benefits from clearing the local water supply will rise to the double that is to say US$ 13,600.

An important factor will be the extent of the area which needs to be cleared. Based on experience it was assumed in the analysis that a well may constitute a clearance task of 0.2 ha. This must be assessed, however, from case to case. Clearance costs will depend on the area size. Possible repair costs should be taken into account. The cleared area will also form basis for an estimate of the benefits from the expected reduced human loss (table A2).

The project can then be evaluated by calculating the BCR. Here the two benefit components, reduced travel distance to fetch water and reduced human loss will be compared to the clearance costs.

Health stations

A similar model as applied above for schools and wells can be used also for calculating the benefits from clearance of health station areas. It was assumed that when the premises are mined, people from the neighbouring villages may have to travel on the average 5 km longer each way to reach the nearest facility. In addition there were presumably 15 persons attending the particular health station on a daily basis (see chapter 6.8).

The total benefits from avoiding this extra travel effort have been calculated to US$ 16,700 in table A7.

Table A7: Cost-benefit analysis of clearance of health stations

Assumptions:	US$ 1000
(1): Benefits from clearance of health stations, US$ 1000	16.7
(2): Additional travel distance 5 km each way	
(3): Persons travelling: 15 daily	
(4): Health stations constitute clearance tasks of 1.2 ha	

The benefits will depend on the extra distance travelled, which should be assessed independently in each case. A 25% larger difference in travel distance between the reopened local health station and the alternatives used before clearance will increase the benefits with 25%.

The size of the local community using the health station, or the number of visitors, will also be of importance. In case of a larger community with 30 daily visitors, the benefits from clearance will be the double that is to say US$ 33,400.

An important factor is the size of the area that needs to be cleared. Based on experience it was assumed in the analysis that a well could constitute a clearance task of 1.2 ha. This must be assessed, however, from case to case. Clearance costs will depend on the area size. Possible repair costs, but not upgrading, should be taken into account. The cleared area will also form basis for an estimate of the benefits from reduced human loss (table A2).

The project can then be evaluated by calculating the BCR. Here the two benefit components, reduced travel distance to the health centre and reduced human loss will be compared to the clearance costs.

Temple areas and tourism

The benefits from clearance of temple areas are related to the net revenues the country can gain from the extra tourists attracted and the expected expansion of the tourist industry. The benefits from opening up an additional km^2 of temple areas have thus been calculated to US$ 1.36 million in extra future revenues (see chapter 6.7).

Table A8: Cost benefit analysis for clearance of temple areas

Assumptions:	US$ 1000
(1): Benefits from opening up 1 km^2 of temple areas	1362
(2): Tourist contribution to GNP: US$ 200 per visitor	
(3): Number of tourists: 800 per km^2 of temple area reopened per year.	

These incomes will be dependent on a number of factors, a contribution to GNP of US$ 200 per visitor, and a number of new tourists amounting to 800 annually per km^2 of temple area reopened. Revised assumptions here will cause corresponding relative changes in the amount of benefits (1), 25% fewer visitors will thus cause 25% less revenues etc.

Revenues and clearance costs will also be proportionate with the size of the area to be cleared and reopened for tourism. The cleared area will also form basis for an estimate of the benefits from the expected reduced human loss (table A2).

The clearance task can then be evaluated by calculating the BCR.

Other buildings

The benefits from clearance tasks involving buildings (public offices etc) can often be related to the corresponding construction costs and/or the value of the terrain. The state of repair of the building must then be taken into account.

A 4: Third step

A third step might consist of courses in cost-benefit analysis in mine action, using the methodology provided in this report or extended versions. The participants would then be introduced to the full version of cost-benefit analysis with the accompanying spreadsheet facilities. New studies could be undertaken based on disaggregated data as appropriate.

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Annex 3: References

1. CMAA (2004): Five Year Mine Action Plan 2004-2008.
2. CMAA (2004): Mine Action Achievements of the Kingdom of Cambodia 1992-2003.
3. CMAA (2004): National Mine Action Strategy 2004.
4. CMAA (2004): Mine Clearance Analysis and Guidance 2004 (National Work Plan 2004).
5. CMAA (2004): Communicating elements of plans to implement Article 5 of the Ottawa Convention
6. Ted Paterson and Mao Vanna (2004): A Study of Capacity Development in Mine Action - Case Study of Cambodia
7. Mine Action Portfolio country team's funding appeal 2005.
8. GICHD/UNDP (2001): A Study of Socio-Economic Approaches to Mine Action.
9. MAG Cambodia Programme, Achievements of MAG in 2003.
10. Council for Social Development (2002) Cambodian National Poverty Reduction Strategy 2003-2005.
11. Richard Moyes (2004): Tampering, deliberate handling and use of live ordnance in Cambodia.
12. NPA (2004): Assessment Report on Agricultural Activities in Malai District.
13. Geoff Harris (2000): The Economics of Landmine Clearance. Case Study of Cambodia (Journal of International Development 12 – 2000)
14. CMVIS: National Census of the victims and survivors of landmines and unexploded ordnance in Cambodia (for the years 2000-2003).
15. CMAA: Activities Report 2002.
16. CMAA: Legal Framework
17. CMAC: Annual Report 2003.
18. CMAC: Annual Report 2003 De-mining Unit 6.
19. RCAF Engineer Forces Command Report: The result of mine and unexploded ordnance clearance 2004.
20. FAO Representation in Cambodia: Annual Report 2002.
21. HALO Trust: Annual Report 2004.
22. National Institute of Statistics: Statistical Yearbook 2003.
23. Cambodia Millennium Development Goals Report 2003.
24. Griffin and Keeley (December 2004): Joint Evaluation of Mine Action in Cambodia.
25. Roath Kanith (2003): A Study on the Evaluation of a Demining Project in Cambodia
26. UNDP (August 2004): Terms of Reference Cost-benefit analysis of mine clearance operations in Cambodia.
27. Royal Government of Cambodia (2003): National Population Policy