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The Socio-Economic Impact of Mine Action in Afghanistan: A Cost-Benefit Analysis

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* The World Bank and Nordic Consulting Group, respectively. The analysis, views, and opinions expressed in this paper as well as the associated data, estimates, and calculations, are the responsibility of the authors and should not be attributed to the World Bank or its affiliated institutions.

Acronyms

ACBAR:	Agency Co-ordinating Body for Afghan Relief
AETF:	Afghan Emergency Trust Fund
Afs:	Afghani (currency)
AMVIS:	Afghanistan Mine Victims Information System
AREA:	Agency for Rehabilitation & Energy Conservation in Afghanistan
ATC:	Afghan Technical Consultants
BCR	Benefit-Cost Ratio
CSO:	Central Statistics Office
DAFA:	De-mining Agency for Afghanistan
DDG:	Danish De-mining Group
DFID:	Department for International Development (UK)
DSA:	Daily Service Allowance
EC:	European Commission
EU:	European Union
FAO:	Food and Agriculture Organization of the United Nations
GDP:	Gross Domestic Product
GICHD:	Geneva International Centre for Humanitarian Demining
HALO:	Hazardous Area Life Support Organization
HI:	Handicap International
ICRC:	International Committee of the Red Cross
IRR:	Internal Rate of Return
MACA:	Mine Action Centre for Afghanistan
MAPA:	Mine Action Program for Afghanistan
MCPA:	Mine Clearance Planning Agency
MDC:	Mine Detection Dog Centre
MDG:	Mine Dog Group
MDS:	Mine Dog Set
META:	Monitoring, Evaluation and Training Agency
MIS:	Management Information System
NCG:	Nordic Consulting Group
NGO:	Non Governmental Organization
NOVIB:	Netherlands Organization for International Development and Cooperation
OMAR:	Organization for Mine Clearance and Afghan Rehabilitation
PRIO:	Peace Research Institute in Oslo
RMAC:	Regional Mine Action Centre
SCA:	Swedish Committee for Afghanistan
SEIS:	Socio-Economic Impact Study of Landmines and Mine Action Operations in Afghanistan
SIMAA:	Study of Socio-economic Impacts of Mine Action in Afghanistan.
UN:	United Nations
UNDP:	United Nations Development Program
UNOCHA:	United Nations Office for the Co-ordination of Humanitarian Assistance to Afghanistan
US$:	United States Dollar
UXO:	Un-exploded Ordnance

Abstract

This study was conducted as part of the World Bank/UNDP "Afghanistan Watching Brief" Project. The main findings and recommendations of the study are outlined below.

The Mine Action Program for Afghanistan (MAPA) earns substantial net socio-economic benefits through its mine clearance activities, which fully justify continuing funding of mine action by the assistance community. The estimated net benefit-cost ratio of MAPA mine clearance activities, using a 10% discount rate and a 15-year time horizon, is 1.2, which translates into a high internal rate of return of 28%.

This conclusion is robust to sensitivity analysis. If the human welfare benefits from reduced mine accidents due to mine clearance are excluded from the calculations, the estimated benefit-cost ratio declines to 0.8, and the internal rate of return becomes 21%. If the estimated number of mine accidents is cut by half and welfare benefits remain excluded, the benefit-cost ratio declines further to 0.6 and the internal rate of return to 19%, still providing a very strong justification for the mine action program.

MAPA's costs are held down by the large-scale use of mine-detection dog teams (the most efficient technique under all conditions where it is feasible), which account for about half of the total mined area cleared. Use of dogs should be further expanded, which will further increase the net socio-economic benefits and reduce costs. Mechanical de-mining in Afghanistan has had low, often negative benefit-cost ratios and should be strictly limited to situations where it is the only feasible technique, and even then based only on a case-by-case assessment of the socio-economic benefits.

Clearance of irrigation systems and roads earns the highest returns and generally should be given top priority, along with highly productive agricultural land. The benefits from clearing grazing land are much more marginal, and hence this activity should generally be assigned lower priority (although it is fully justified if efficient de-mining techniques are used).

Priority should be given as per MAPA guidelines to clearance of land that will immediately be put back into productive use once it is free of mines. This could be assured, for example, through credible community commitment achieved by means of consultations.

It is roughly estimated that clearing the remaining minefields identified by MAPA as high-priority would cost about $200 million, and that clearing other minefields would cost another $250-300 million, depending on how many previously undiscovered minefields are found.

Regular, systematic use of cost-benefit analysis should be introduced into the operational decision-making process for mine clearance. Improved and more systematic data collection is needed for this purpose. In particular, the information base on mine accident victims needs to be improved (including through a household survey if one is conducted in Afghanistan).

Greater community participation should be encouraged in the planning and prioritization of mine action, on the basis of full information on relative costs and benefits of different options.

Differences in unit costs among mine action NGOs need to be looked into. In order to improve cost-efficiency while maintaining quality and safety standards, **competitive bidding for de-mining contracts among technically qualified de-mining agencies could be introduced gradually over time,** perhaps on a pilot basis initially.

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Executive Summary

The Situation

1. Afghanistan is among the most mine-affected countries in the world, a legacy of more than two decades of conflict starting with the occupation by the Soviet Union in the 1980s. A total area of about 940 sq. km. of mine-contaminated land has been identified and surveyed as of October 2000, and additional minefields are still being discovered in previously unsurveyed areas, at a rate of 14-16 sq. km. per year. Laying of mines has continued sporadically in some parts of the country (mainly re-mining of previously mined areas). In addition to landmines, there are large amounts of unexploded ordinance (UXO), concentrated in numerous former battlefields and elsewhere throughout the country.

2. Two hundred and twenty sq. km. of land have been cleared of mines during more than a decade of mine action operations, leaving about 720 sq. km. remaining to be cleared, of which 340 sq. km. has been designated as "high priority" by the Mine Action Program for Afghanistan (MAPA). The bulk (86%) of this 340 sq. km. consists of agricultural and grazing land, together with smaller amounts of roads and residential areas and small (but economically important) areas of irrigation systems and canals.

3. Landmines have taken a devastating toll of human lives, health, and livelihoods in Afghanistan. Although the data are deficient, this study estimates that in mid- to late-1990s there were on average some 500 victims per month from mine and UXO accidents, of which around 30% were fatalities (although recent data suggest that the incidence of mine accidents may have fallen in 2000). Another indication of the human toll from mines is the large number of disabled persons, most of whom among the civilian population are mine/UXO victims. For example, among amputees who have been registered at the ICRC orthopedic project in Afghanistan since it began work in 1988, 78% are reported to be victims of mines. Beyond the loss of economic productivity and individual welfare for the victims and the inability to productively utilize mine-contaminated land, the human cost of mines to victims' families, their communities, and to Afghan society as a whole is enormous.

The Mine Action Program

4. The Mine Action Program for Afghanistan (MAPA) started operations in 1989. It is a mature program which has gained a great deal of experience during more than a decade. Consisting of the UN Mine Action Centre for Afghanistan (MACA), four UN Regional Mine Action Centres (RMACs), and 15 NGO implementing partners, MAPA has a total workforce of some 4,800 Afghans and less than 10 expatriates.

5. MAPA is financed primarily from the UNOCHA (the United Nations Office for the Coordination of Humanitarian Assistance) Afghanistan Emergency Trust Fund. Some funds are also passed from donors directly to individual NGOs. Spending on the mine action program has been substantial – on the order of $20 million per year in recent years.

6. During its existence, MAPA has cleared a total of 221 sq. km. of minefields, disposing of 220,000 mines in the process. MAPA is also responsible for clearance of UXO; more than 300 sq. km. of former battlefields have been cleared and 1.2 million pieces of UXO removed. The area of minefields cleared by MAPA has gradually increased in recent years, reaching its highest ever level of 34 sq. km. in 1999. The area of former battlefields cleared nearly doubled in 1999, reaching a peak of 76 sq. km. MAPA and other agencies also engage in mine awareness raising activities, which account for about 70% of MAPA's total budget.

7. The average unit cost of de-mining in 1999 according to MAPA was US $0.6 per sq. m. After various adjustments, this study comes up with an estimate of US $0.77 per sq. m. of minefields cleared and US $ 0.04 per sq. m. of former battlefields cleared in 1999. These cost estimates include capital spending, in-kind contributions, the socio-economic costs of mine accidents to de-miners (which affected 0.5% of the de-mining labor force in 1999), and administrative overheads (including expatriates' costs). It is not surprising that clearance of UXO is much cheaper than mine clearance since UXO is generally much easier to handle.

8. MAPA has pioneered and experimented with a number of innovative techniques to enhance the productivity and safety of de-mining activities, including use of back-hoes and other mechanical devices in urban areas (especially for clearing mines from collapsed structures) and large-scale deployment of mine-detection dogs (which for the most part are bred and trained locally). Thus the Afghanistan mine action program includes a rich variety of different de-mining techniques being used to clear different types of land.

The Study and Its Methodology

9. Although substantial resources that have been devoted to mine action in Afghanistan by the assistance community (a total of some $150 million during 1991-1999), a careful evaluation of the socio-economic benefits and costs of this program was not conducted prior to this study. This reflects in part past conceptual approaches to mine action: (1) the "military" approach (i.e. clearing bottlenecks to movements of people and vehicles – echoed in the more recent emphasis on removing "blockages" to communities) and (2) the humanitarian approach (saving lives). But mine action is also (3) a development activity, since it allows those saved from becoming victims of mine accidents to live out economically productive and personally rewarding lives and also brings mine-contaminated land back into productive use. Moreover, whether it is considered a humanitarian or development activity, the mine action program must in any case compete with other worthy humanitarian and development-oriented programs for limited resources available from the assistance community. Hence this long overdue study was commissioned as part of the "Afghanistan Watching Brief" Project funded by the World Bank and jointly supervised by UNDP and the Bank. The study takes a comprehensive approach to the evaluation of de-mining, encompassing the "military", humanitarian, and development perspectives.

10. The main objective of the study was to estimate, in as comprehensive a manner as possible with available data, the socio-economic costs of mines (and correspondingly the benefits of de-mining) and the costs of mine clearance activities. On this basis a socio-

economic cost-benefit analysis of mine action in Afghanistan would be conducted. Specifically, the study was expected to assess the overall socio-economic returns reaped by the resources devoted by the assistance community to mine clearance. It was also intended that the study would provide some operational guidance to MAPA with respect to (1) the prioritization of different types of land for mine clearance and (2) the choice of de-mining techniques. Another objective of the study was to provide a conceptual framework and methodology, as well as to identify data needs, for regular use of cost-benefit analysis by MAPA in its operational decision-making. Although not part of its explicit objectives, the study may also provide useful guidance for socio-economic cost-benefit analysis of mine action programs in other countries. On the other hand, data limitations and conceptual difficulties precluded a rigorous analysis of mine awareness activities, although this subject is touched on in the paper.

11. The methodology applied is standard cost-benefit analysis, i.e. calculating the ratio between net benefits (gross benefits minus costs of mine clearance) and costs of mine clearance. Both costs and benefits are converted into net present value terms, using a discount rate of 10% per annum and a 15-year time horizon, and internal rates of return also are calculated. Since de-mining involves clearance of land contaminated by mines, it is most appropriate to conduct the cost-benefit analysis in terms of units of land area (sq. km. or sq. m.) cleared of landmines.

12. Conceptually, the socio-economic costs of landmines can be divided into three broad categories: (1) loss of life, health, human production potential, and human welfare resulting from mine accidents; (2) denial of access to mine-infested land and loss of associated production or consumption benefits from the land concerned; and (3) distortion of behavior due to the existence of mines with consequent socio-economic losses resulting from longer travel distances, journeys not undertaken due to greater distance and difficulty, and other distortions in behavior.

13. In line with the above categorization of the costs of landmines, the specific socio-economic benefits of mine clearance that this study focuses on are (1) the gains in economic productivity due to reduced human losses from mine accidents; (2) the corresponding savings in medical costs; (3) the improvement in human welfare attributable to reduced human losses from mine accidents; (4) the net economic benefits attributable to returning reclaimed land to productive use; and (5) reduced losses of livestock from mine accidents (on those types of land used by livestock). Land is divided into the following categories: agricultural land, irrigation systems and canals, roads, grazing lands, and residential areas. For agricultural, irrigation, and grazing lands, the benefits consist of the estimated net value added of the production on the land after clearance (including in the case of irrigation the agricultural land served by irrigation systems cleared of mines), plus the socio-economic benefits of fewer mine accidents. Reduced loss of livestock from mine accidents is included as a benefit in the case of agricultural land, roads, and grazing land. Clearance of mines from roads results in reduced travel times and lower transport costs, which are estimated as the main economic benefits. For residential land, property values are used as the indicator of the benefits from mine clearance.

14. Turning to the costs of mine clearance, the direct costs (recurrent and capital), overhead costs, and socio-economic costs of mine accidents during mine clearing operations together comprise the total cost of de-mining. The cost estimates are derived by calculating the average cost of de-mining per unit of land area, based on data available from MACA and its mine action partners. Allocation of these costs between different de-mining techniques (manual, mechanical, dogs, and community de-mining – of which there is only one example, a pilot program) is based on partial data from individual de-mining NGOs.

15. Whereas the data on the costs of de-mining are likely to be reasonably complete and accurate (at least in aggregate), important but difficult to quantify benefits are left out in the calculation of the socio-economic benefits of de-mining. These include greater family and community resilience due to being required to support fewer disabled mine victims, social stability, and the psychological benefits attributable to being free from worry about mines in a locality, among other benefits. Moreover, the socio-economic costs of mines (and corresponding benefits from mine clearance) associated with longer travel distances and times as a result of the need to avoid minefields (for example in going to collect water or firewood) are not incorporated in the cost-benefit analysis except in the case of mined roads (where the main benefit of mine clearance is in the form of reduced travel distances, times, and costs). While these important benefits that are excluded from the analysis do need to be kept in mind, the range of benefits included is broad and comprehensively encompasses elements of the "military", humanitarian, and development approaches to mine action.

16. Use of the estimated net value added of production on de-mined land as the indicator of land-related benefits from mine clearance assumes that the labor inputs for this production do not have alternative productive uses. In the Afghan context of an extremely weak economy with widespread unemployment, as well as a large pool of refugees who would return to Afghanistan if conditions warrant, this assumption is probably not unreasonable. In fact, making land and associated productive income generation opportunities available to returning refugees (in areas where there is no conflict) is an important objective of the assistance community's overall strategy for support to Afghanistan.

17. It is implicitly assumed that mines are the only significant factor preventing productive utilization of the cleared areas, and that no costs beyond those incorporated into the net value added calculations will need to be incurred to bring the land concerned back into production. This also may not be an unreasonable assumption in most cases, since ability to immediately bring land back to productive use is one of the main criteria that MAPA uses in determining which minefields should be designated as high-priority.

18. While the methodology used in this study is straightforward, the available data are deficient. Although some additional data were collected as part of the study, data collection was not its main focus. Hence estimates and in some cases assumptions were used as necessary to fill gaps in the data.

19. The calculation of economic benefits was made manageable by developing stylized case studies, covering eight different regions of the country (demarcated by provincial boundaries), based on farming models developed from the Swedish Committee for

Afghanistan's agricultural survey and subsequent data from FAO. The eight case studies are considered to be representative of over 95% of irrigated agricultural land and 85% of rainfed agricultural land. The regional case studies are used for calculation of the socio-economic benefits from de-mining of agricultural, irrigation, and grazing land. In the case of irrigation systems and canals, an adjustment is made to ensure that the benefits are not overstated (due to double–counting of benefits from clearance of agricultural land and clearance of irrigation systems associated with that land).

20. In the case of roads, two stylized case studies were developed, one representing high-traffic areas in or close to urban settings, the other representing the much lower traffic levels prevalent in rural areas. Two case studies also were developed for residential land, one for Kabul and Kandahar and other large cities where property values are relatively high, the other for the rest of the country.

21. Data on mine accident victims are incomplete, and there are substantial differences among the various available sources of information. The study attempted to reconcile the data and came up with its best estimate of the numbers of mine accident victims in 1999 attributable to designated high-priority minefields: 4,000 per year, of which 31% are estimated to be fatalities. Based on assumptions about differences in accident risks for different types of mine-contaminated land, estimates were made of the numbers of mine accident victims per year for the five different categories of land. These figures are subject to improvement through further data collection and analysis. In particular, reports of lower numbers of mine accident victims more recently would need to be investigated and assessed.

22. Evaluating the socio-economic loss due to deaths and serious injuries from mine accidents raises important conceptual and methodological issues. This study calculates the net present value of lost economic production and individual welfare of victims of mine accidents, plus medical costs for victims with serious injuries (blindness, amputation, or other similar severe injuries). The estimated net present value of the total individual socio-economic loss for a mine accident fatality is $11,700, which is very conservative even taking into account Afghanistan's poverty. For the average mine victim (a composite of 31% fatality, 46% blindness or amputation, 12% other severe injuries, and 11% light injuries), the socioeconomic loss is estimated at $9,000.

23. Based on the estimated number of mine accident victims per sq. km., these figures can be used to derive estimates of the socio-economic cost of mine accidents per unit area of minefields. It is assumed that in the absence of mine clearance activity, the rate of accidents would decline by 5% per year due to survey and delineation of the minefields, explosion and deterioration of mines, adaptation by the local people, precautionary behaviors, and mine awareness efforts.

24. In addition to estimating the ratio of net benefits to costs for each individual case study, this data can be used to put together an estimate of the overall socio-economic benefits of MAPA operations. Specifically, the case studies' estimates of socio-economic benefits per unit of land area can be multiplied by the amounts of different types of land in different

regions cleared by MAPA in 1999, using different de-mining techniques, to derive an estimate of total socioeconomic benefits.

Main Findings

25. Based on the methodology described above, the study calculated socio-economic benefit-cost ratios for clearance of the five categories of land (agricultural land, irrigation systems and canals, roads, grazing land, and residential areas) in eight regions of the country (where relevant), using three types of de-mining techniques (manual, mechanical, and dog teams). In addition, the total net benefits and benefit-cost ratio for MAPA activities as a whole were estimated for 1999.

26. The study found that MAPA's mine clearance activities generate substantial socio-economic benefits (net of costs). The net benefits are estimated at $ 31 million in 1999, resulting in a very solid net benefit-cost ratio of 1.2. The corresponding internal rate of return is 28%, well above any normal cut-off points used in the socioeconomic analysis of public sector or aid-financed investments.

27. A sensitivity analysis was conducted by excluding the estimated human welfare losses due to mine accidents. This reduced the estimated net benefits to $ 20 million, resulting in a benefit-cost ratio of 0.8 and a still very respectable internal rate of return of 21%. If in addition the estimated number of mine accident victims per year is cut in half (i.e. to 2,000), the benefit-cost ratio declines to 0.6 and the internal rate of return to 19%. Thus the socio-economic justification for mine action appears to be quite robust to changes in important estimates/assumptions used in the analysis, especially when it is kept in mind that there are additional, non-quantifiable benefits from mine clearance for individuals, families, communities, and societies. Moreover, even if there has been a significant reduction in the incidence of mine accidents in the last year or so (which some reports suggest), the sensitivity analysis demonstrates that the socio-economic returns to de-mining would still be sufficiently high to fully justify the resources devoted to the mine action program.

28. Concerning the choice of de-mining techniques, clearance by teams using mine detection dogs is overall the best method, with the highest benefit-cost ratios for all types of land where use of dogs is feasible. On average dog teams have cleared 3.5 times as much mined land per team-hour as manual teams during the period 1990-2000 (first half), whereas the cost per team-hour of dog teams has been somewhat lower than that of manual teams. This translates into an estimated 4 to 1 cost advantage for dog teams per unit of area cleared. Mechanical de-mining (back-hoe – the only mechanical de-mining technique used extensively in Afghanistan) is about 1/3 less costly per team-hour than manual de-mining, but since less than one-fourth as much land is cleared per team-hour, the cost in terms of land area is nearly three times as high for mechanical de-mining as it is for manual techniques (and more than 10 times as high as for dog teams). Moreover, the productivity advantage of dog teams has been increasing over time and reached 4.8 to one during the period 1998-2000 (first half).

29. The very large cost differences cited above translate into much lower socio-economic benefit-cost ratios for mechanical de-mining (use of back-hoes, the only mechanical technique utilized to a significant extent in Afghanistan). In the case studies the net benefits for mechanical de-mining are negative in the case of grazing land, residential areas, much agricultural land, and some irrigation land. Mechanical de-mining tends to be used on the more difficult minefields, such as those where there is rubble from collapsed building structures. Nevertheless, the high costs and low or negative net socio-economic benefits associated with mechanical de-mining do suggest assigning lower priority to such activities. The costs of clearance, using mechanical techniques or any other techniques, may be prohibitively high in such cases.

30. Turning to the benefit side, clearance of irrigation systems and canals not surprisingly carries the highest socio-economic returns, followed by roads, agriculture, and then, with much lower returns, grazing land. Clearance of residential areas also shows high benefit-cost ratios, but these are based on property values, as opposed to the estimated productive value of the land which was used in the other case studies. Hence caution should be exercised in prioritizing mine clearance activities on the basis of the estimated benefit-cost ratios for residential land. Clearance of grazing land carries the lowest cost-benefit ratios – positive for dog teams but significantly negative for manual and mechanical de-mining techniques. Based on the case studies, clearance of irrigation canals and roads is well justified, clearance of agricultural land and residential areas also is strongly justified if dog teams are used, and clearance of grazing land is justified only if dog teams or community de-mining is used are used but not other techniques.

31. There is considerable variation across regions in the net benefits of mine clearance for agricultural and irrigation land, since land productivity varies greatly. Although the case studies are intended to be roughly representative, actual socio-economic returns would vary according to the specific characteristics of the land being cleared, the density and types of mines, the cost-efficiency of the de-mining agency, and other factors affecting the difficulty of mine clearance.

32. As mentioned earlier, one mine action NGO is conducting community-based de-mining on a pilot basis. This makes use of communities' human resources and know-how and involves participation by trained community members in mine action activities, with payment in the form of food-for-work or a nominal salary. Only lower-priority minefields, not containing anti-tank mines or minimum-metal mines, are being cleared by this method. Although the experience has been limited so far, it appears that this approach may be very cost-effective.

33. The study strongly endorses MAPA's criterion that priority should be given to clearance of land that will immediately be put back into productive use when it is free of mines. Significant delays in productive utilization of de-mined land sharply reduce the discounted present value of the socio-economic benefits and thereby weaken the justification for mine clearance. Hence targeting land where there is a reasonable guarantee that it will be immediately put back into productive use (for example based on credible community commitment achieved through consultations) makes good sense.

34. The sensitivity analysis that was conducted does not change the ranking of socio-economic benefits for different types of land and different techniques. However, more case studies show negative benefit-cost ratios for certain techniques. Whereas these ratios remain significantly positive for mine dog teams in clearance of all types of land except grazing areas, mechanical de-mining carries negative net socio-economic benefits in most cases, and manual techniques become marginal or negative except for irrigation canals and roads.

35. Based on the unit cost data calculated in this study, it is possible to roughly estimate the cost of clearing the remaining identified and surveyed minefields in Afghanistan. The average estimated unit cost of $0.77 per sq. m. should be reduced somewhat, however, to take into account efficiency improvements that would result from scaling up and further increasing the use of mine-detection dogs. Hence a figure of $0.60 (20% lower) is used. On this basis, it is roughly estimated that clearing the remaining minefields identified by MAPA as high-priority would cost about $200 million, and that clearing other minefields would cost another $250-300 million, depending on how many previously undiscovered minefields are found. In a situation where there is an end to conflict and large numbers of refugees and displaced persons return to their homes, land use and movements of people will increase (with associated higher risks of mine accidents), so it will make sense to expand the de-mining program and make faster progress toward eliminating the problem of landmines for the bulk of the Afghan people.

36. Although this study did not conduct a detailed cost-benefit analysis of UXO clearance, the cost per unit area of land cleared is much lower than in the case of de-mining. This strongly suggests that the sharp increase in UXO clearance activities in recent years is well-justified. Better data on accident victims, which clearly distinguish between mine and UXO accidents, would be helpful in assessing the socio-economic justification for UXO clearance and its appropriate priority vis-à-vis mine clearance.

Implications and Recommendations

37. This study's findings confirm that mine clearance activities in Afghanistan generate substantial overall net socio-economic benefits, even when conservatively estimated, and therefore that continuing funding of mine action by the assistance community is well-justified. The Afghanistan mine action program is also found to be relatively cost-effective, due mainly to the large-scale use of dog teams for mine detection. However, the study also suggests that there is scope for further improvements and makes a number of recommendations in this regard.

38. Regular, systematic use of socio-economic cost-benefit analysis should be introduced in the operational decision-making of the mine action program. This will promote better prioritization of activities and use of the most appropriate de-mining techniques, further increasing the net socio-economic benefits of mine action and improving cost-effectiveness. Of course, cost-benefit analysis should not be applied in a rigid or mechanical manner but needs to be used flexibly in line with local conditions. Building on the generic stylized case studies put forward in this study, general guidelines can be developed for prioritizing de-

mining activities. Simplified templates for cost-benefit analysis also could be prepared, which could be used ex ante to guide operational decision-making and ex post for evaluation.

39. Expanded and more systematic use of cost-benefit analysis requires better data. Information on the numbers of victims of mine accidents is incomplete and should be improved through better data collection and coordination among the agencies responsible. Data on mine accident victims gathered as part of a broader household survey would be very useful in assessing the longer-term impact of mines on Afghan society as a whole. On the benefit side, alternative methods for calculating the benefits of clearing commercial and residential land can be developed.

40. Greater community participation in the planning and prioritization of mine clearance activities is highly desirable and would complement regular use of cost-benefit analysis. For example, community consultations could form the basis for determining whether there is a reasonable assurance that land cleared of mines will immediately be put back into productive use, which as noted above is critical for achieving high socio-economic returns in practice. Community participation in some aspects of mine action, where feasible and appropriate, also should be explored further, based on the apparently successful experience with a small pilot program.

41. Among different types of land, clearance of irrigation systems and roads should generally receive top priority since they generate the highest net socio-economic benefits, while clearance of productive agricultural land also is highly beneficial and should be given priority. The measurable socio-economic benefits from clearing grazing land are considerably lower and are estimated to be positive only in the case of de-mining with dog teams or community-based de-mining. Clearance of residential land appears to carry high socio-economic benefits, but further work is needed to place these estimates on a more comparable basis with those for other types of land.

42. Since dog teams constitute the most efficient technique for de-mining under all conditions where use of dogs is feasible, their use should be expanded further (at present they account for just under half of the total area being cleared of mines on an annual basis). This would be mainly at the expense of manual de-mining. Mechanical de-mining (back-hoe technique) appears to earn marginal or negative net socio-economic benefits in most cases, so it should be strictly limited to situations where it is the only feasible technique (e.g. collapsed structures with multiple layers of mines). Even then, the returns should be assessed on a case-by-case basis before proceeding, as the costs in many cases would not justify mechanical de-mining. Experimentation with new mechanical techniques should continue in the interest of exploring possibilities for developing more efficient mechanical approaches to de-mining.

43. The recommended shift in the mix of de-mining techniques in favor of dog teams would reduce the labor-intensity of the mine action program (i.e. the amount of labor required per unit of land area or per mine cleared). However, since the cost of dogs is relatively low and de-miners are still needed to physically extract the mines, the cost structure of mine dog teams remains skewed in favor of wage costs as opposed to the cost of

dogs and other costs. Thus the main effect of use of dog teams is sharply increased labor productivity with a modest shift in cost structure. In the short run, increased use of mine dog teams could be leveraged into a substantial increase in the volume and pace of de-mining work. Over the longer term, resources could be redeployed to other parts of the assistance program.

44. There appear to be significant differences in efficiency and costs among de-mining agencies. Although the study could not go into this aspect in detail, there may be scope for improvements in the operational efficiency of mine clearance activities. It is recommended that possible cost differences among different de-mining agencies be analyzed more thoroughly. Such a review should also examine staffing and labor productivity levels in the different mine action NGOs. Depending on the outcome of such a review, it may be necessary to explore measures to improve cost-efficiency. A promising option in this regard would be competitive bidding for de-mining contracts among technically-qualified de-mining agencies, based on explicit technical and safety qualification requirements. Such a change would need to be well-prepared, and could be started initially on a pilot basis before being gradually expanded. Competition in this manner would provide stronger incentives for the high-cost mine action NGOs to improve efficiency and contain costs.

45. In conclusion, a number of areas for further work have been identified. The information base on mine accident victims needs to be improved (including through a household survey if one is conducted in Afghanistan). More systematic work on mine awareness activities and their impact would be helpful in assessing this component of the mine action program. A socio-economic evaluation of UXO clearance (which would require better data on numbers of UXO accidents and victims) would provide a better basis for prioritizing MAPA's activities as between mine and UXO clearance. And simplified methodologies, guidelines, and templates should be developed for regular, systematic use of cost-benefit analysis in MAPA's operational decisionmaking.

1. Introduction

This study of the socio-economic impact of mine action in Afghanistan is part of the World Bank-funded "Afghanistan Watching Brief" program, jointly implemented by UNDP and the World Bank. This program has supported three main types of activity: (1) economic and sector studies on topics of importance for the Afghan economy and for international assistance to Afghanistan (including trade, agriculture, and remittances in addition to mine action); (2) conferences, workshops, and inter-agency teamwork on topics of interest to the assistance community (for example, education, health, and food security); and (3) short-term training for Afghan women NGOs based in Peshawar, Pakistan to improve their job-related skills.

In view of the substantial resources that have been devoted to mine action in Afghanistan by the international assistance community (totaling some $150 million during 1991-1999), a careful evaluation of the socio-economic benefits and costs of this program was overdue. Hence this study was commissioned, with broad terms of reference, in early 2000.

The main objective of the study was to estimate the socio-economic costs of mines (and correspondingly the benefits of de-mining) and the costs of mine clearance activities. On this basis a cost-benefit analysis of mine action in Afghanistan would be conducted. More specifically, the study was expected to assess the overall socio-economic returns reaped by the resources devoted to mine clearance. It was also intended that the study would analyze and provide some operational guidance to the Mine Action Program for Afghanistan (MAPA) with respect to (1) the prioritization of different types of land for mine clearance and (2) the choice of de-mining techniques. Another objective of the study was to provide a conceptual framework and methodology, as well as to identify data needs, for regular use of cost-benefit analysis by MAPA. The study was expected to include some discussion of issues related to mine awareness activities, community participation in mine action prioritization and decisionmaking, and unexploded ordnance (UXO), but it was not expected to analyze these topics in detail.

A Steering Committee consisting of representatives from the World Bank, UNDP, and MAPA was appointed to guide and support the work for this study. The work involved extensive data gathering, processing, and analysis, relying heavily on the database of the Mine Action Center for Afghanistan (MACA). There were field visits to Afghanistan in June and October 2000. In addition, there were several interactions in Pakistan, including meetings with the Steering Committee and a preliminary donor briefing on the scope and methodology of the study in September 2000.

Despite serious deficiencies in the available data, discussed in detail later in this paper, the study was able to achieve its main objectives. An initial draft report was prepared in December 2000, and it was subsequently revised in February 2001 and then in April 2001. The report was presented at the international conference on "Analytical Foundations for Assistance to Afghanistan: Perspectives from the Afghanistan Watching Brief Project" which was held in Islamabad, Pakistan on June 5-6, 2001. Substantial revisions in the report were made subsequently in the light of comments received at the conference and further work in certain areas.

After some brief background discussion on Afghanistan's economy in Section 2, a summary of the history of mines in Afghanistan in Section 3, and an introduction to the mine action program in Section 4, the substantive analysis in this paper is organized as follows:

Section 5 assesses the human cost of mine accidents. For the purposes of the socio-economic cost-benefit analysis, this involves estimating the accident risk represented by active minefields, quantified as the expected numbers and types of mine accident victims per unit area of high-priority mine-contaminated land. It is also necessary to derive an estimate of the cost of loss of life and serious injuries due to mine accidents, including loss of human production capabilities, reduced human welfare, and medical costs.

Section 6, using eight stylized case studies for different regions of the country, evaluates the economic loss associated with mine-contaminated agricultural land and correspondingly the economic benefits of clearing mines from agricultural land.

Section 7 conducts a similar analysis of irrigation systems infested by mines.

Section 8 analyzes the economic costs of mine-infested grazing areas and of mine accidents to livestock, and the corresponding benefits from clearing grazing land.

Section 9 looks at the problems created for transport and travel in Afghanistan by mine-infested roads and the economic benefits from reopening road links that have been blocked by mines for traffic.

Section 10 discusses mines in residential areas and estimates the economic benefits of mine clearance for residential areas.

Section 11 addresses the cost side of the equation – the total costs of MAPA mine action operations, the cost per de-mining team-hour of work, the productivity of teams (in terms of area of mine cleared per hour), and ultimately MAPA's cost per unit of land area cleared. The unit costs are calculated for different de-mining techniques.

Pulling together and building on the earlier analysis, Section 12 presents and discusses the results of the socioeconomic cost-benefit analysis of mine clearance.

Section 13 briefly discusses two topics which the study was not able to cover in depth: clearance of UXO from former battlefields and mine awareness-raising activities.

Section 14 looks briefly at the community dimension and how it relates to socio-economic analysis of mine clearance.

Section 15 recapitulates the main findings and recommendations of the study.

2. Brief Overview of Afghanistan's Economy

There has never been an accurate Census or other precise data on Afghanistan's population. In 1979 the total population of Afghanistan was estimated at 14 million, whereas at present the population in-country (not including refugees in Pakistan and Iran) is estimated at 18-20 million. Before the war about 85% of the people lived in rural areas, including 1.5 million nomads. About 70% of the total labor force was engaged in agriculture, livestock, and livestock-based handicrafts. Even before the war Afghanistan was one of the world's least developed countries. The past 20 years of conflict have exacerbated poverty, deprivation, and suffering.

Afghanistan's pre-war economy was mainly based on agriculture and animal husbandry. The country has a low population density due to difficult topographical and climatic conditions (high mountains covering most of the country, extremes of temperatures, and arid to semi-arid climate). In 1978 – the last year of peace – Afghanistan was largely self-sufficient in food and was a significant exporter of agricultural products. Agriculture was largely concentrated in narrow river valleys and plains where irrigation water from snowmelt was available. Manufacturing industry was largely undeveloped, with only a few plants established (in textiles, medicines, cement, etc.). Afghanistan's strategic position during the Cold War period made it a large recipient of foreign aid, which funded the running of a centralized but relatively weak state without substantial domestic taxation. Also largely as a result of foreign aid, the country had a relatively good major road network, as well as some other infrastructure including major irrigation and hydroelectric facilities. This modern infrastructure, however, did not extend beyond the main arteries and urban centers. Social and other services (such as education and health) were largely limited to the relatively small urban sector.

The long drawn-out war of Soviet occupation and subsequent internecine conflict severely damaged Afghanistan's economy. By the mid-1990s, most of the country's limited modern infrastructure was destroyed, and traditional irrigation systems greatly suffered from destruction and lack of maintenance. Even more important than the physical damage was the increasing breakdown of the state over time and the progressive erosion of institutions – both modern and traditional – which had governed the pre-war economy. Government-provided social services, which had never had a strong outreach into the rural areas, atrophied and to a large extent stopped functioning. Inflation wiped out the value of the Afghan currency in the 1990s. Agricultural output came down sharply, livestock herds were depleted, and large-scale industries almost ceased functioning. Millions of Afghans became refugees in neighboring Pakistan and Iran, and to a lesser extent elsewhere. This diaspora played an important role, however, in supporting Afghanistan's economy through remittances. And finally, as discussed in the following section, land and infrastructure were widely and indiscriminately sown with landmines, causing enormous human and economic losses.

There was a modest economic recovery in the mid-1990s in areas that became largely free of conflict. Agricultural production increased; livestock herds sharply rose in numbers, taking advantage of widely available unutilized grazing lands; and horticultural production also grew based on restoration and expansion of orchards and vineyards. Substantial numbers of refugees returned to their home with international assistance. The economic recovery was concentrated in areas of the country taken over relatively early by the Taliban (who now control about 90% of the country); they removed barriers to trade and restored a certain degree of order. However, the deterioration in social services (particularly education) was aggravated by the Taliban's social policies, which largely excluded women from work and girls from school.

The introduction of a certain degree of stability in large parts of the country also facilitated the growth of various kinds of unofficial economic activities, most notably long-distance trade (particularly re-exports to Pakistan) and opium poppy cultivation. Although these activities had always been present, they underwent unprecedented expansion in the 1990s. Unofficial exports to Pakistan are roughly estimated to have exceeded $2 billion in 1996, and by the late 1990s Afghanistan had become the largest producer of opium poppy in the world. Also falling in this category of economic activities is uncontrolled exploitation of natural resources – timber, gems, marble and granite, etc. – which have resulted in extensive deforestation and environmental degradation, among other problems.

Most recently, Afghanistan has been hit by a severe, protracted drought, which started in 1999 and has lasted until the present. Crop production has been halved and livestock herds heavily depleted. Large and increasing numbers of people have lost their means of livelihood and have become displaced, either internally or to neighboring countries. Malnutrition has significantly worsened, and starvation deaths have been reported. The impact of the drought, which would have been serious under any circumstances, has been aggravated by the continuing conflict in parts of the country (particularly in northeastern and central Afghanistan), and by the run-down condition of irrigation systems and other agricultural infrastructure.

In sum, Afghanistan's economic structure has been gravely weakened, distorted, and made more vulnerable through two decades of conflict. Agriculture (including livestock), the most important licit economic activity, is highly vulnerable to natural conditions as is demonstrated by the current drought. Trade activities are vulnerable to the policies of neighboring countries, most notably Pakistan – in fact, there appears to have been a substantial decline in Afghanistan's unofficial re-exports to Pakistan in the recent past, probably reflecting changing policies and enforcement behavior in Pakistan. Remittances, another major source of income, are probably more stable, but nevertheless they are vulnerable to changes in economic conditions in the source countries. The Taliban's recent complete ban on opium poppy cultivation, which is a very positive move and has been largely effective, has sharply reduced the incomes of those small farmers and rural wage laborers who were dependent on poppy cultivation and related work. Foreign aid, another important albeit smaller source of income, has increased sharply in the wake of the drought but also is subject to fluctuations.

Afghanistan's economic situation has significant regional spill-over effects – through unofficial trade, narcotics and other illegal activities, financial flows, and movement of people. These spill-over effects tend to undermine revenue collection, governance, and the effectiveness of economic policies in neighboring countries, particularly Pakistan. The long drawn-out conflict situation, without an effectively functioning state much of the time, has led to a situation where conflict-related or conflict-enabled economic activities and structures have become entrenched, and there are significant groups who are benefiting from the current situation and therefore have a vested interest in its continuation.

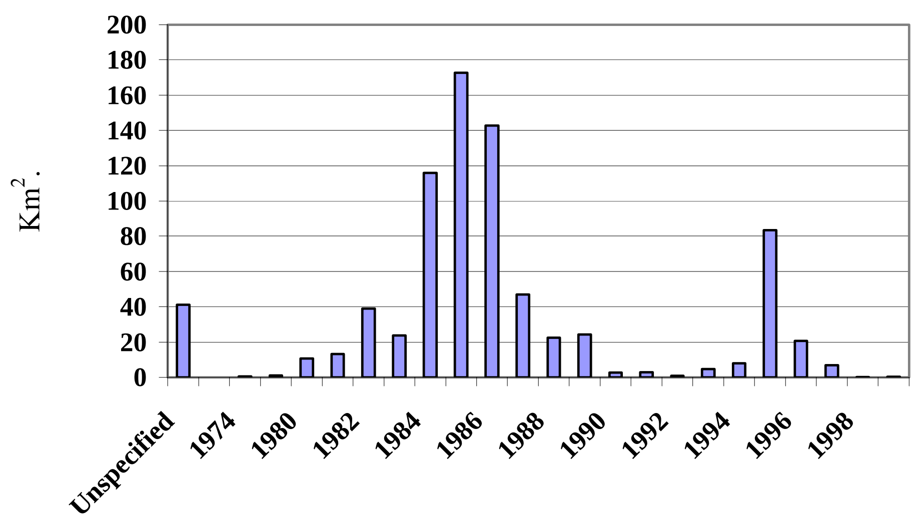
Although all of these problems are daunting, and peace is obviously a prerequisite for the strong recovery and sustained rapid economic development that Afghanistan desperately needs, there is nevertheless potential for economic improvement in normal (i.e. non-drought) climatic conditions. Freeing people and land from the scourge of landmines is a precondition for economic progress under either a peace or a conflict scenario.

3. The History of Mines in Afghanistan

Afghanistan is among the most mine-affected countries in the world. During the Soviet occupation of 1980-1989 and the subsequent war between Afghan government troops and the resistance forces, landmines were used indiscriminately. Mines were used for conventional military purposes, and also as part of the Soviet strategy to depopulate villages in order to eliminate local support for the resistance. Mines were therefore placed in houses, irrigation systems, agricultural land, and grazing areas, as well as being used for conventional military purposes on roads and around military establishments. Guerrilla forces used mines to block roads and to harass opponents. Modern delivery systems enabled mines to be scattered by helicopters and other aircraft. In addition there are huge amounts of unexploded ordnance (UXO) on former battlefields and scattered throughout the country.

As can be seen from Figure 3.1, the bulk of mine contamination took place in the 1980s, with a peak of mine-laying in the mid-1980s. However, some new deployment occurred in the mid-1990s. In recent years deployment of new mines has not been significant.

Figure 3.1: Minefields in km^2 by Year of Mining



Source: MACA MIS Survey Database

Landmines and UXO are scattered throughout the country – in urban and commercial areas, towns, and villages, as well as on farmland. Mine and UXO contamination affects 28 of the 29 provinces, with heavier concentrations and greater impact in the eastern region, including Kabul, and in the southern and western regions.

By the end of October 2000, the remaining area contaminated by landmines throughout Afghanistan was estimated at 718 km^2 (see Table 3.1). Of this, 339 km^2 are assessed as high priority – vitally important residential areas, commercial land, roads, irrigation systems, and productive land.

Table 3.1: Mine Contamination in Afghanistan, Situation at end-year 2000

	Area km²
Total mine contaminated area identified to date	938
– of which high priority area	560
Area cleared to date – all high priority	220
Remaining area to be cleared	718
Remaining high priority area to be cleared	339
– Agricultural areas	153
– Residential and commercial land	14
– Irrigation systems and canals	3
– Roads	32
– Grazing areas	137

Source: MAPA MIS Survey Database

National data on the rate of mine and UXO casualties are not available, but the limited data that have been collected show a grim picture. Non-combatant casualties may have been as high as 150 to 300 a month in the mid- to late-1990s, but more are believed to die before receiving medical treatment.

It is estimated that access to 87,500 houses has been blocked by landmines[1], constituting one of the major obstacles to the return of refugees and internally displaced persons to their villages.

Current assessments indicate that if the remaining 339 km^2 of high-priority mined area can be cleared, most Afghans could resume a normal, productive life. This will take some 7-10 years if current funding levels for mine clearing are maintained. The extent of new mining throughout the country was investigated in 1998 and again in late 1999 by MAPA. While a concern, the amount of new mine-laying does not appear to be substantial. Old minefields are still being discovered, at a rate of 14-16 km^2 a year. These areas were mined years ago but are discovered by MAPA when different parts of the country become accessible.

Table 3.2: New Minefields Found, in km²

Year	2000-Oct.	1999	1998	1997	1996
km²	12.5	16.4	14.0	15.6	13.6

Includes both high and low priority mined areas.

During the years of war from 1978 onward, up to one-third of the population fled the country or was internally displaced. Many farming areas were depopulated. In 1993 the UN launched an emergency relief and rehabilitation program for Afghanistan, to enable and encourage people to return to their homes. A key element of this program was to bring agricultural land back into production, in order to provide food and employment for the returnees. This required significant efforts in removing mines and UXO from access roads and agricultural land, and restoring abandoned irrigation systems.

[1] Source: SEIS page 16.

In many countries it has been observed that the number of dead and injured from mine accidents tends to peak as refugees and displaced persons return to their homes. It then descends rapidly over the following months and years, even in quite severely affected countries. The peak years for mine incidents in Afghanistan appear to have corresponded with periods of large-scale repatriation. One peak year could have been 1988, when the Soviet army began its withdrawal. There was an upsurge of resistance activity and some Afghans repatriated voluntarily. No survey or clearance had taken place by that time and minefields were active and unmarked. In 1990, the year after the final withdrawal of Russian troops, there was also some repatriation into the country. During the period 1992-1994 some 2.5 million Afghans returned home. Following this spontaneous repatriation, there appears to have been a considerable increase in the number of mine victims. The deficient data on victims cannot provide any confirmation of this, however.

4. The Mine Action Program for Afghanistan

The Mine Action Program for Afghanistan (MAPA) started operations in 1989. Since then it has expanded from a few hundred de-miners assisted by a dozen foreign experts to a workforce of some 4,800 Afghans and fewer than 10 expatriates.

MAPA consists of the UN Mine Action Centre for Afghanistan (MACA), four UN Regional Mine Action Centres (RMAC), and 15 implementing partners (NGOs). In the absence of an indigenous national co-ordinating body, MACA plans, manages, and oversees all mine action activities for Afghanistan as well as providing technical support and ensuring proper integration of mine action into the humanitarian assistance program of the country. The 15 NGOs implement most physical activities associated with mine action, including awareness raising, technical training, survey, and clearance.

MAPA's field of activities comprises:

- Surveying and clearing of minefields and former battlefields.
- Mine and UXO awareness and education.
- Technical training and program development/management.
- Advocacy: The Afghan Campaign to Ban Landmines.
- Landmine survivors rehabilitation and reintegration.

MAPA has pioneered the development of a number of innovative techniques to enhance the productivity of de-mining teams, including the use of back-hoes in urban areas and the large-scale deployment of mine-detection dogs. During its 10 years of activity, the program has cleared 220 km^2 of minefields and over 300 km^2 of contaminated former battlefields, removing over 220,000 mines and 1.2 million pieces of unexploded ordnance (UXO) in the process (see Figure 4.1 and Table 4.1 below).

Figure 4.1: Clearance km^2 by Year

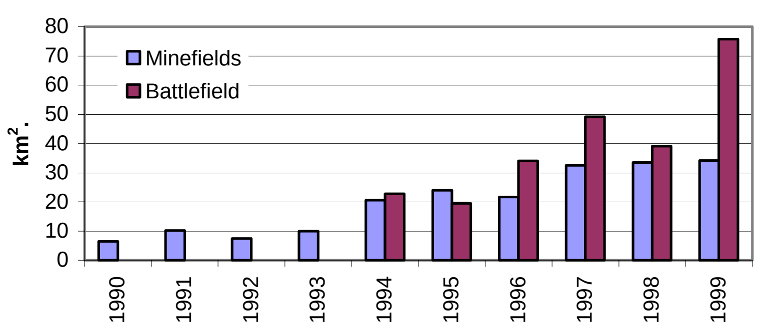


Table 4.1: Clearance of Minefields and Former Battlefields, 1990-2000, km^2

Year	1990-2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Minefields	220.6	34.2	33.5	32.6	21.6	23.9	20.7	9.9	7.4	10.2	6.4
Battlefields	303.7	75.7	39.1	49.2	34.1	19.5	22.7				

Despite political divisions and conflict within the country, MAPA has been able to operate successfully in all areas. The program continues to receive strong support and recognition from the warring factions in Afghanistan and the Afghan population in general, as well as from the international community.

The major part of the mine action NGOs' funding is channelled through the UNOCHA Afghanistan Emergency Trust Fund (AETF), which is administered by UN Organization for Coordination of Humanitarian Assistance (UNOCHA) in Geneva. Table 4.2 shows trends in MAPA funding through AETF for the period from 1991 to 1999, and also MAPA's reported cost of clearing in US$ per m^2. Unit costs have come down significantly over the last decade. The figure US$ 0.6 per m^2 is frequently used in MAPA's reports as the unit cost of mine clearance.[1] However, some other factors need to be taken into account to give a more complete picture:

AETF is not the only source of funding. Some NGOs receive support, financial and in kind, directly from donors. Information about this support has not been collected for the MAPA annual reports of previous years, whereas all areas cleared of mines are reported as MAPA activity.

MAPA activities also include clearance of UXO from former battlefields, over 300 km^2 in the period 1990-2000 as compared to about 220 km^2 of minefields. The time (in team-hours) it takes to clear a former battlefield is less than 1/30 of the time required to clear a minefield of equal size. Nevertheless, clearance of former battlefields is not a negligible part of the activity and influences the cost of the program.

MAPA is also engaged in other activities covered by the same budget, most notably mine awareness. Some of the NGOs supported by MAPA are engaged in mine awareness exclusively, while others are active in both mine clearing and mine awareness. Mine awareness constitutes US$ 1.8 million out of the total of US$ 26.3 million requested by MAPA as funding for the year 2000, i.e. about 7% of the total.

Table 4.2: AETF Funding for MAPA in Million US$ and Cost per m^2 of Minefields Cleared During 1991-1999

Year	1999	1998	1997	1996	1995	1994	1993	1992	1991
US$ mill.	22.1	22.2	20.2	17.7	15.6	16.9	17.4	11.1	7.9
US$/$m^2$ minefield	0.6	0.7	0.6	0.8	0.7	0.8	1.8	1.5	0.8

After survey (level 2), minefields and former battlefields are assigned priority as to which ones should be cleared first. Taking the decision on this is normally the responsibility of MAPA's four Regional Mine Action Centers (RMAC). Prioritization is in accordance with the following guidelines:

1st Priority: Agricultural land, roads, housing/residential areas, and irrigation systems, expected to be reclaimed immediately by users.
2nd Priority: Same types of land, expected to be put in use after six months.

[1] See for example MAPA: Annual Workplan for Year 2000, page 32.

3rd Priority: Same types of land, expected to be put in use after 2-3 years.
4th Priority: Grazing areas, and also some agricultural land or roads.
5th Priority: Grazing areas only.

The areas declared to be of high priority in Table 3.1 will correspond to 1st Priority here. Some grazing areas have also been considered high priority.

5. Estimating the Human Loss from Mines

5.1 Mine Victims in Afghanistan

The devastating toll on human lives and health is unquestionably the most cruel impact of mines and UXO. Quantitative information on the human loss is to a large degree deficient, as the available data on mine victims in Afghanistan suffer from lack of reliability and completeness. Moreover, data collection efforts by different agencies are not well-coordinated.

Various studies have been conducted , and data continue to be collected regularly by various agencies like ICRC, MAPA, Save the Children, and local NGOs. The degree to which the data are representative and provide reliable information about the situation in the entire country is questionable, however. No available data source constitutes anything close to a complete count, and there is evidence that many mine accidents involving dead and wounded victims are not reported anywhere. Data collection efforts are not based on a well-conceived sampling technique, and double-counting may occur in the data reported by different agencies.

It is not surprising, therefore, that different sources give widely varying figures for the number of mine victims in Afghanistan:

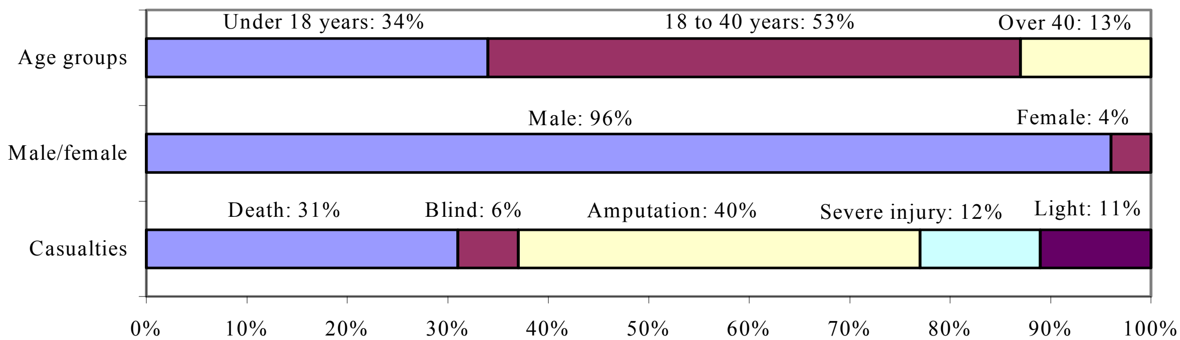
- The MAPA Annual Workplan for 2000 states that the number of mine accident casualties may be as high as 150 to 300 a month, but it adds that many more are believed to die before receiving medical treatment.[1]
- The SEIS (Socio-Economic Impact Study of Landmines and Mine Action Operations in Afghanistan) study's estimate for a recent year (1997) is 10-12 a day or 300-360 a month, representing a decline from 20-24 people a day or 600-720 a month in 1993.
- ICRC (Red Cross) in Kabul's assessment is 300 to 500 a month based on mine casualties arriving at their hospitals.
- The AMVIS (Afghanistan Mine Victims Information System) initiative estimates the total accumulated number of victims (dead and survivors) to be around 60,000 by year 2000.
- SEIS presents estimates for the total number of landmine victims amounting to 90,000-104,000 as of the end of 1997.

The SEIS study, based on data from 5,140 mine accident victims, provides some information on the age and gender composition of victims and the types of injuries suffered. From the SEIS study, it appears that the vast majority (96%) of civilian mine and UXO casualties are male. Afghan men may be more exposed to mines than women in their daily activities. It might also be the case that female casualties are significantly underreported, and that women are less likely than men to present themselves for treatment at hospitals. The death rate among the reported casualties is about 30%, and a further 40% have to undergo

[1] MAPA: Annual Workplan for Year 2000, page 16.

amputation. The serious categories of injuries make up altogether about 90% of the registered casualties. It is likely that light injuries are seldom reported. The SEIS study also observes that a considerable share (about 40%) of the victims were educated, at least having completed primary education. Moreover, about half of the victims were responsible for supporting their families.

Figure 5.1: Mine/UXO Injuries as Percentage of Injured Persons in Reported Accidents



Source: MCPA, Socio-Economic Impact Survey 1999 (SEIS)

The ICRC Orthopedic Project in Afghanistan has five centers, located in Kabul, Mazar-e-Sharif, Herat, Jalalabad and Gulbahar. Since this project started in 1988, over 36,000 patients have been registered. Due to large demand and the almost complete absence of alternative facilities, in 1995 the project extended assistance to non-amputees and non-war wounded patients as well. Of the total number of amputees at the ICRC centres, 78% are registered as victims of mines, 70% are civilians, 82% adult males, 8% boys less than 14 years of age, 7% women, and 3% girls under 14. The ICRC data thus also indicate that there is a rather small proportion of females among the mine victims.

For the purposes of the socio-economic analysis in this study, the total number of civilian mine accident victims is estimated by combining the ICRC and SEIS data. The following adjustments are made:

- The patients registered with ICRC also include non-civilians and non-mine victims. The ICRC data have been corrected to exclude these patients, based on the detailed breakdown available from ICRC.
- ICRC's data on registered patients include mainly amputees and only a relatively small proportion of non-amputees. In the SEIS survey, amputees constitute 40% of all reported mine accident victims on average, and other severe injuries 12%. It is therefore assumed that the ICRC patients comprise all amputees and half of the severely injured from mine accidents.

With these adjustments, the total number of civilian mine accident victims has been estimated for the period from 1995 to 1999, as shown in Table 5.1. The total number of victims is estimated to have remained at about 500 per month during most of the years in this period, including in the first four months of 2000 based on ICRC patient registrations. The estimated number of mine accident victims in 1995 was lower than in the other years and in 1999 somewhat higher.

Table 5.1: Estimated Mine Accident Victims 1995-2000

	2000-April	*1999*	*1998*	*1997*	*1996*	*1995*
Civilian mine victims	2062	7553	6089	5872	5989	3661
Mine victims/month	515	629	507	489	499	305
- Deaths/month	155	189	152	147	150	92

Source: Calculated figures based on adjusted ICRC and SEIS information

In the Report of the National Survey of Mines Situation from 1993,[2] a total of 339 districts in all 29 provinces of Afghanistan were surveyed. Mine problems were reported in 162 of these districts. Surveys could not be carried out in 17 districts due to security problems, and 177 districts were reported free of mines. In the surveyed communities, it was found that over 20,000 people had been killed and about 16,000 disabled through mine accidents. With this background, the survey report estimated that 20-25 mine incidents involving the civilian population occurred in Afghanistan every day, or about 8000 every year. The percentage of deaths in this survey was 55%, a higher proportion than the 31% recorded in the SEIS study from 1999.

A regression analysis of the data from the 1993 National Survey clearly indicates that the number of mine victims is positively related to the area of high-priority minefields and the population (number of families) in a locality. The area of low-priority minefields seems to be of little significance, as would be expected. A problem with the 1993 survey from an analytical point of view is the lack of information about the time period when accidents took place. On the other hand, the SEIS data does not have any information on where mine accidents occurred.

For further analysis it is most convenient to apply an Accident Risk concept, defined as the danger represented by an active minefield expressed in terms of the expected number of casualties per year and per km^2 of mined area. Given the deficient statistics on mine victims in Afghanistan, however, such calculations require a number of assumptions. Not only does the number of mine accident victims need to be estimated, but the size of the mined area on which these accidents occur is uncertain. New mined areas continue to be identified, including some high-priority minefields. While the total area of high-priority minefields identified as of the beginning of 2000 amounted to 530 km^2, the real area could be as much as 600 km^2. Out of this area, 200 km^2 have been cleared, leaving 400 km^2 as a reasonable estimate of the total uncleared high-priority mined area in Afghanistan in 2000.[3]

The corresponding number of mine victims can be estimated at 4,000 per year, as shown in Table 5.2. This figure is not meant to comprise the total civilian mine and UXO victims in Afghanistan, which may be in the range of 6,000 per year. Instead, it covers only

[2] MCPA 1993: Report of the National Survey of Mines Situation.

[3]This estimate is somewhat higher than the total area of identified high-priority minefields that have not yet been cleared. If it overstates the actual area of uncleared high-priority minefields in existence, the number of casualties per unit area would be underestimated, imparting a downward bias to the human cost of mines and correspondingly to the socio-economic benefits from mine clearance.

the victims of mine accidents taking place on the 400 km^2 of uncleared high-priority minefields. Victims of mine accidents taking place on low-priority areas and victims of UXO accidents, whose total number undoubtedly is substantial, are not included. The estimate of 4,000 mine victims per year represents the number of casualties that could be avoided if the 400 km^2 of high-priority minefields are cleared. This estimate yields an Accident Risk of 10 victims annually per km^2 of high-priority mined area in Afghanistan.

Table 5.2: Calculation of Estimated Accident Risk

Year	*2000*
Identified high-priority mined area km^2.	530
Estimated actual high-priority mined area km^2.	600
Cleared minefields km^2.	200
Estimated active high-priority minefields km^2.	400
Estimated number of victims/year	4000
Victims per day	11
Victims/km^2 mined area/year	10

Different types of mined areas generate different accident risks, and those close to populated areas will normally be the most exposed. It is normally the case that mined residential/commercial areas, irrigation canals, and roads carry the highest risk, while agricultural areas carry somewhat less and grazing areas the least risk of mine accidents. Specific data on mine accident risks for different types of land is not available, however. Hence based on available qualitative information and impressions, it will be assumed that the risk of mine accidents is twice as great on mine-contaminated agricultural land as on grazing land, and three times as great on residential land as on grazing land.

These assumptions, along with the earlier estimates, provide the basis for the risk calculations presented in Table 5.3 on the number of victims annually per km^2 of different types of mined land. The accident risks for each type of land are calibrated such that when multiplied by the estimated areas of different types of high-priority minefields, the total number of victims on the 400 km^2 of high-priority minefields is 4,000, for an average of 10 victims per km^2 per year.

Table 5.3: Risk of mine accidents – Estimated Number of Victims Annually per km^2 on Different Types of Mined Area

Type of area	Victims/km^2
Residential/commercial	17
Roads	17
Irrigation systems	17
Agricultural land	11
Grazing areas	6
Average/total	10

5.2 Valuation of Lost Human Welfare and Production Capacity

The accepted methods for valuation of the human loss from accidents are based on the resources needed to correct the effects of the accident, i.e. what it would cost society to restore the victim or his/her relatives and friends to the situation in which they found themselves before the accident.

The Human Capital Approach measures the loss to society when one of its members dies or becomes disabled, based on the value of working time or value of production the individual is responsible for. According to this method, the cost of death or disablement is calculated on basis of the lost future productive potential of the victim. Production for future years is discounted to the present date using a stipulated discount rate, which has been set at 10% per year in this study. Production may be calculated in gross or net terms. In the latter case expenditure on consumption is deducted, leaving the production loss to society excluding the victim.

The Value of Lost Lifetime Years method attempts to incorporate the value of the leisure time in addition to working time. The loss of enjoyment suffered by the victim on his death is not limited to deprivation of consumption. It extends to cover the fact that he can no longer undertake other activities promoting his or her well being.[4]

Many European countries, Australia, and the USA apply such methods for valuation of human life and losses due to injuries in connection with road accident prevention programs. A fatality can be valued at as much as US$ 2 million and a very serious injury at US$ 1.5 million based on these methods. Estimates of the human costs of accidents can be used to justify major road safety programs, some of them quite costly to the road transport sector.

The method selected for evaluating the human cost to individuals of mine accidents in Afghanistan will be close to the Value of Lost Lifetime Years approach. It will include the estimated loss of productive capacity to society and reduced opportunities for the victim to conduct activities important for personal welfare, including private consumption and the estimated value of leisure time. The calculations presented here constitute a first effort to evaluate the reduced human losses from mine accidents as benefits attributable to mine clearance activities in Afghanistan. Both the method applied and the data used are subject to further revisions and refinements.

The starting point for these calculations is an estimate of the social value of production for an individual mine victim. Information about the age structure and other characteristics of mine victims is extracted from Figure 5.1. The SEIS study observes that a considerable share (about 40%) of the victims were educated, at least having completed primary education, and that about half of the victims were responsible for supporting their families. Thus it can be assumed that most mine victims belonging to the economically active age groups (18-65 years) are contributing positively to national economic activity. An

[4] European Commission Transport Research Cost 313: Socioeconomic cost of road accidents, 1994.

unemployment rate of 40% will be applied, however, to take into account Afghanistan's very weak economy. The economic situation of mine victims is thus different from refugees or internally displaced persons returning to reclaim land cleared of mines, who generally will be assumed to have no alternative possibilities for employment (see Section 6).

The Gross Domestic Product (GDP) of a poor country can be as little as US$ 200 per inhabitant per year. For Afghanistan, no National Accounts statistics exist at present, so a rough estimate of US$ 200 for average per-capita income per year will be used. It can be assumed that the largest part of the GDP is created by people in the age group of 20-65 years. By applying estimates for the number of persons in that age group in Afghanistan[5] and assuming an unemployment rate of 40%, it can be estimated that each active, employed person in a poor country (with an average per-capita GDP of US$ 200) would contribute about US$ 750 annually to GNP. This will be used as the basis for estimating the potential annual economic contribution from a mine victim (96% of them males) in the age groups of 18-40 years and above 40 years. It will also be used to estimate the potential economic contribution of young persons once they reach productive age.

GDP includes private consumption, but it is limited to marketed goods and services. The value of non-marketed economic activity and production for own use should be added, which could increase the production value estimate to US$ 850 per person per year.

Estimation of a mine accident victim's personal loss of welfare inevitably is arbitrary, but it can be assumed to be at least equal to the individual's productive contribution. So the conservative estimate used here will be an additional US$ 850 per person per year, whereas estimates from industrialized countries often constitute a much higher additional percentage.

Table 5.4: Estimates of Productive Contribution and Loss of Welfare for Mine Victims

	US$/year
Contribution to GDP	750
Value of non-marketed, subsistence production	100
Productive contribution from an economic active mine victim	850
Victim loss of welfare	850

A 30-year-old male can be treated as representative of the middle of the age group 18-40 among mine victims. His remaining life expectancy is about 35 years in Afghanistan.[6] There is also a risk of loss of a person's productive capacity for reasons other than death and mine accidents. An average productive lifetime of 30 years will thus be assumed for the age group of 18-40 years. For the age group over 40, the productive lifetime is assumed to be 10 years and life expectancy 15 years. Victims under 18 are assigned a remaining life expectancy of 50 years and a remaining productive life of 40 years when they reach productive age, on average after 10 years. Future contributions are all discounted at a 10% annual rate.

[5] Mohammad Ershad: Paper on the population of Afghanistan, IIPS Bombay, June 1983.
[6] Ibid.

The individual age groups of the population in Afghanistan are assumed to contribute to lost production value and welfare loss according to their shares in the total number of mine accident victims, which are shown in Figure 5.1. As mentioned earlier, for calculation of the lost production value an unemployment rate of 40% is assumed. This reduces the estimated production loss to 60% of the estimated contribution, i.e. $450 per year for persons in the productive age groups.

The total human loss per person for a typical fatal mine accident casualty is calculated in net present value terms in Table 5.5. The resulting estimate of less than $12,000 is very low, reflecting Afghanistan's deep poverty and the conservative approach and assumptions used. The estimated human loss for other, non-fatal categories of victims will be less and will depend on the degree of disability, as discussed later in this Section.

Table 5.5: Production and Welfare Loss per Person, Fatal Casualty, US$

Production loss	Years	Loss US$ Over lifetime	% of victims	Loss US$ relative share
Age group under 18	40 (+10)	3 211	34	655
Age group 18-40	30	8 013	53	2 548
Age group over 40	10	5 223	13	407
Welfare loss				
Age group under 18	50	8 434	34	2 868
Age group 18-40	35	8 198	53	4 345
Age group over 40	15	6 465	13	840
Economic loss per person fatal casualty				11 663

5.3 Medical Costs

Mine accident victims constitute a heavy burden on the scarce resources available for medical treatment in Afghanistan. ICRC reports that over 80% of all amputations performed at their hospitals are on victims of landmines. Patients with serious injuries from a landmine will need hospital treatment for about 30 days on the average. The cost per patient-day at an ICRC hospital is around US$ 120, excluding salaries of expatriate staff. The average cost for treating a mine-injured person in an ICRC hospital will therefore be around US$ 3,500. For most Afghan families, this would be an unattainable amount. At ICRC hospitals all treatment is free of charge, but nevertheless treatment capacity and resources are being diverted from other patients. So there is a high opportunity cost involved, and the resources used for mine accident victims have valuable alternative uses. In any case, the victim and his/her family may also have to cover additional expenses like transport.

Many mine accident victims do not receive professional medical treatment, which may contribute to a higher death toll and to more permanent, debilitating injuries. As a result, however, medical costs per victim would be somewhat lower on average than the hospital rates. Thus it is assumed that medical costs will amount to US$ 2,000 per victim in the case of casualties leading to blindness, amputation, and other severe injuries.

5.4 Total Human Loss in Socio-economic Terms

The estimated socio-economic loss shown in Table 5.5 constitutes the loss attributable to a fatal human casualty. The death toll from mine accidents in Afghanistan is estimated at 31% of the total number of victims. The proportion of different types of casualties can be taken into account in accordance with their respective degree of disability. The estimated contribution of each category of mine accident victim to the human loss is shown in Table 5.6, based on the proportion of different categories of injuries and assumptions about the degree of disability entailed by each category of injuries relative to a fatality. Medical costs are also added, at the rate of US$ 2,000 per victim for casualties leading to blindness, amputation, and other severe injuries. The economic loss for a typical mine victim calculated on this composite basis is about US$ 9,000.

Table 5.6: Economic Loss for a Typical Mine Accident Victim, US$

Categories	Disability %	Victims %	Loss US$
Death	100 %	31 %	3 616
Blind	70 %	6 %	610
Amputation	60 %	40 %	3 599
Severe injury	50 %	12 %	940
Light injury	20 %	11 %	257
Economic loss for a typical mine victim			**9,021**

The total human loss in socio-economic terms can now be distributed across the various types of mined areas according to the accident risk estimates presented in Table 5.3. As long as mined areas are not cleared, the risk of mine accidents will persist, and human casualties may continue to recur every year. So a 15-year time horizon is used, during which the human loss will be calculated and discounted at 10%.

Experience indicates, however, that the accident risk from active mined areas decreases somewhat over time, even when no clearance has been conducted. Local people may adapt themselves in various ways to the dangers of mines, taking precautions and modifying their behavior. Mine awareness campaigns may have a significant impact in this respect, as well as the survey, delineation, and marking of minefields. Such risk reduction activities also carry some costs. Return of refugees, on the other hand, may well offset any declining trend and increase accident rates. For the purpose of the cost-benefit analysis in this study, it is conservatively assumed that accident rates will decrease by 5% every year over the 15 year time horizon under consideration, if no mine clearance activity occurs.

Table 5.7: Human Loss in US$ 1000 from Risk of Accidents on Different Types of Mined Area per km^2, Annually and Over 15 Years Discounted at 10%

Type of area	Accident risk victims/km^2	Annual loss US$ 1000	Total human loss over 15 years, US$ 1000*
Residential/commercial	17	154	914
Roads	17	154	914
Irrigation systems	17	154	914
Agricultural land	11	103	610
Grazing areas	6	51	305
Average for all mined areas	10	90	535
One victim each year over 15 years**	1	9	69

* A reduction in accident risk of 5% per year over the 15 years period is assumed.
** No risk reduction assumed.

With an accident risk of 10 victims per km^2 of minefield, the total human loss as an average for all types of areas is estimated at US$ 90,000 km^2 annually. This translates into a net present value of loss of more than US$ 0.5 million per km^2 when the area concerned remains uncleared during a 15 year period. Each type of mined area carries different levels of accident risk, and the human loss from accidents varies accordingly.

5.5 Alternative Assumptions

Although mine accidents unquestionably lead to major human welfare losses, these are difficult and somewhat arbitrary to measure and inevitably become a source of contention no matter what estimates or methodology are used. The estimated welfare loss can be excluded for the purpose of sensitivity analysis, not because this is unimportant or necessarily overstated, but rather to come up with a more conservative estimate of the benefits of de-mining that are directly attributable to economic activities. Table 5.8 shows the revised estimates of human losses resulting from exclusion of welfare losses (with all other assumptions maintained as in Table 5.7). The average annual human loss per km^2 with welfare losses excluded comes to US$36,000, which translates into a total discounted loss of about US$ 210,000 over a 15-year period.

As a further sensitivity check, since the calculations of human loss are based on the estimated incidence of mine accidents (for which reliable nationwide data are lacking), it can be very conservatively assumed that instead of 4,000 mine accident victims per year, there are only 2,000. This almost certainly substantially understates the incidence of mine accidents, but nevertheless it is useful for the purposes of sensitivity analysis to make use of a rock-bottom calculation of the human loss from mine accidents. The combination of excluding the estimated welfare loss and halving the estimated rate of mine accident casualties results in estimates of the total human loss which are exactly half of those shown in Table 5.8.

Table 5.8: Human Loss Based on Alternative Assumption Excluding Welfare Loss

Type of area	Accident risk Victims/km^2	Annual loss US$ 1000	Total human loss over 15 years, US$ 1000*
Residential/commercial	17	61	364
Roads	17	61	364
Irrigation systems	17	61	364
Agricultural land	11	41	243
Grazing areas	6	20	121
Average for all mined areas	10	36	213
One victim each year over 15 years**	1	4	27

* A reduction in accident risk of 5% per year over the 15 years period is assumed.

** No risk reduction assumed.

6. Agricultural Land Blocked by Mines[1]

6.1 The Agricultural Sector's Role in Afghanistan's Economy

Afghanistan is an agricultural country, and traditionally around 70% of the labor force has been engaged in agriculture-related activities. Agricultural production is one of the main components of Afghanistan's the Gross Domestic Product (GDP). Before 1979, the contribution of agriculture comprised of more than 50% of total GDP.

In 1978, the last year of peace before the Soviet invasion, the country was largely self-sufficient in food and was a significant exporter of agricultural products. Official Afghan statistics from the period 1971-1989 show annual exports of agricultural products of more than US$ 100 million, constituting over 30% of the total exports of the country. The main export items were fresh and dried fruits, citrus fruits, and oilseeds. After the intensification of war activities, agricultural production decreased considerably. There was subsequently a recovery of agricultural production in the 1990s, concentrated in areas free of fighting, especially the Taliban-controlled areas in Southern, Eastern, and Western Afghanistan. This recovery was cut short by the current three-year drought, which halved food production and devastated horticultural production and livestock. As a result of the drought, Afghanistan's food deficit has widened alarmingly, and there has been widespread displacement of population.

In Afghanistan, 85% of the agricultural output comes from about 5% of the land – the fertile and productive river valleys – which to a large extent consist of irrigated areas. Three quarters of the total land area, on the other hand, supports only sparse grazing in mountainous and arid areas. Basic data on agricultural land use in Afghanistan prior to the war are shown in Table 6.1.

Table 6.1: Land area and use of land in Afghanistan, 1972

	km²	*%*	*%*
Irrigated land			
– Orchards	802	2	
– Cereal crops, 2 times a year	4,514	14	
– Cereal crops, once a year	7,337	22	
– Intermittently cropped	20,230	62	
Total irrigated	32,883	100	5
Rainfed-only 20-25% cropped every year	48,357		8
Forest area	19,870		3
Rangeland and other	541,285		84
Total land area	642,395		100

Source: FAO Land Use Statistics, 1972

[1] This section has benefited in particular from co-operation with the FAO office in Islamabad as well as different FAO reports and publications and the survey undertaken by the Swedish Committee of Afghanistan (SCA). However, responsibility for the use of this data in this study and the specific conclusions drawn rests with the authors.

Estimates for 1996 of the production of principal crops and average yields in tons per km^2 are presented in Table 6.2.

Table 6.2: Principal Crops and Yields in Afghanistan, Estimates for 1996

	Area km^2	*Yield Tons/ km^2*
Wheat	36,000	170
Barley	3,100	115
Maize	4,850	170
Rice	2,150	210
Cotton	800	145
Sugar cane	45	2
Sugar beet	20	2
Fruit orchards, citrus	700	43
Vegetables	900	790

Source: FAO Integrated Crop Program Estimates

6.2 Mines in Agricultural Areas

A total of 89 km^2 of agricultural land has been cleared of landmines during the period from 1990 to 2000. According to MAPA's estimates,[2] a total of 153 km^2 of high-priority agricultural land still remained to be cleared by the end of 1999. Another 26 km^2 of mine-contaminated agricultural land has been assigned lower priority.

Table 6.3: Mines in Agricultural Areas, km^2

Year	*1990-2000*	*1999*	*1998*	*1997*	*1996*	*1995*	*1994*
Cleared land km^2	89.1	17.6	14.1	11.8	8.1	6.6	6.6
Remaining by 2000							
– High priority	153.2						
– other area	26.2						

6.3 The Case Studies

The data used in this study should be comprehensive and detailed enough to cover all of Afghanistan, and to give a representative picture of the various different types of agricultural areas relevant in a mine clearance context. There are, however, serious gaps and deficiencies in the available data on Afghanistan.

It has therefore been necessary to collect and analyze economic data for a limited number of stylized case studies. The individual cases have been designed so as to represent as best possible the full range of different agricultural conditions in Afghanistan. In the interest of manageability, the area covered by each case study coincides with the boundaries of one or a group of provinces. District-level case studies would be too detailed. Moreover, a restricted number of cases have been selected, which could be expanded later. In the agriculture and livestock sectors, the need for a minimum of eight stylized case studies has

[2] Source: MAPA Annual Workplan for Year 2000.

been identified, in order to cover the major climatic zones, main cropping and livestock holding patterns, and cultivation practices.

The stylized case studies are based on farming models developed from the Swedish Committee for Afghanistan's agricultural survey of 1991. They describe the farming systems prevailing in different agro-ecological zones, which can be considered representative of the climatic variations across the country. The basic features of these models are described in terms of location, altitude, precipitation, type of irrigation, farm and household size, crop production, farm inputs, draught power, and livestock production.

Cropping intensity varies among the eight case studies. Depending on micro-climate and availability of water, some areas with fertile soil and high temperature can be cultivated more than once per year, whereas other agricultural land can be used only once every two to three years. Some districts of Laghman and Nangarhar can be cropped up to three times per year, whereas large areas in the Northern Region, rain-fed land in particular, must remain fallow for 3-4 years or even longer at a time. The irrigated agricultural lands which are not being cropped every year can be used as grazing areas or left unused to increase nitrogen content.

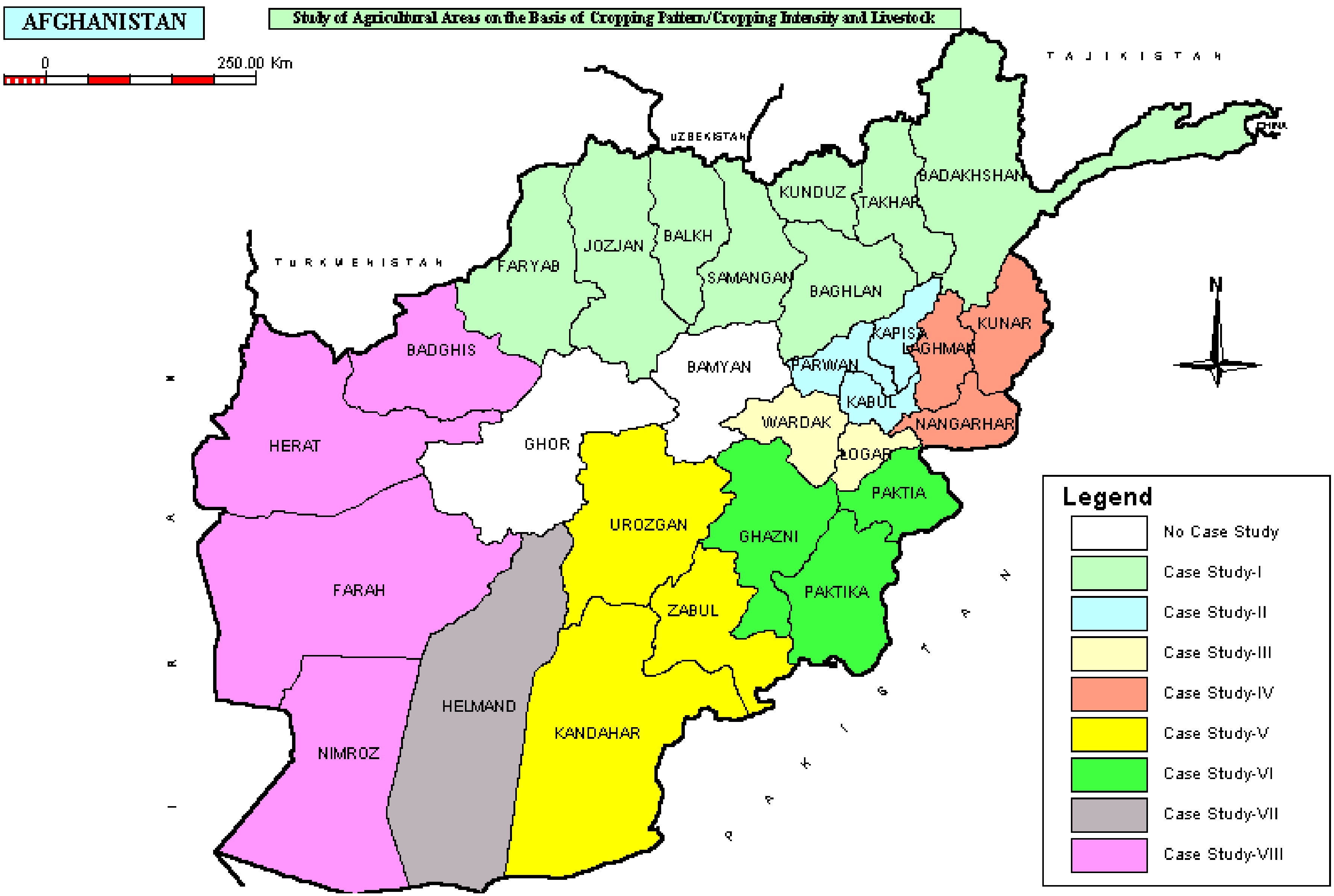
Together, the stylized case studies are considered to be representative of over 95% of Afghanistan's irrigated agricultural land and 85% of rain-fed land. Case study I covers a mixed extensive rain fed and irrigated cropping system, whereas case studies II-VIII are concerned only with irrigated cropping systems. This means that the associated cost-benefit analysis relates primarily to productive agricultural land that has regular access to irrigation water.

The provinces covered by the eight case studies for the agricultural and livestock sectors are shown in Table 6.4 and illustrated in the map that follows. Out of the 29 provinces in Afghanistan, only two provinces – Bamiyan and Ghor – are not covered by the case studies. These provinces are not densely mined; no clearance report has yet been received from Ghor, and less than 0.5 km^2 have been cleared in Bamiyan.

Table 6.4: Case Study Areas

Case Study	Provinces, Regions
I	Northern Region all provinces*
II	Parwan, Kabul, Kapisa.
III	Logar, Wardak.
IV	Nangarhar, Laghman, Kunar
V	Kandahar, Zabul, Oruzgan
VI	Ghazni, Paktika, Paktia
VII	Helmand
VIII	Herat, Badghis, Farah, Nimroz

******The Northern Region consists of the provinces of Faryab, Jawzjan, Balkh, Samangan, Kunduz, Baghlan, Takhar, Badakhstan.*


AFGHANISTAN
Study of Agricultural Areas on the Basis of Cropping Pattern/Cropping Intensity and Livestock
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BAGHLAN
KAPISA
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BAMYAN
BADGHIS
KABUL
WARDAK
NANGARHAR
LOGAR
HERAT
GHOR
PAKTIA
UROZGAN
GHAZNI
FARAH
ZABUL
PAKTIKA
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Legend
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Case Study-I
Case Study-II
Case Study-III
Case Study-IV
Case Study-V
Case Study-VI
Case Study-VII
Case Study-VIII

6.4 Economic Benefits From De-mining Agricultural Land

For the purposes of the cost-benefit analysis conducted in this study, it is assumed that agricultural areas will be put into productive use immediately after being cleared of mines. There is considerable demand for agricultural land in the country to feed the population and provide livelihoods for returning refugees. Besides, according to MAPA's guidelines, an area will not be given first priority for clearance if there is considered to be a significant chance that it will not be reclaimed for use immediately.

The economic benefits from agricultural land consist of the net revenue to the farmer from the associated agricultural production, which in this report is calculated on an annual average basis and per km^2 of area. For each of the eight agricultural case studies, a crop pattern assumed to be representative for the region has been identified, consisting of the percentage share of land area devoted to each different crop.

Regional variations in cropping intensity have been taken into account. Cropping intensity varies, in particular, with rainfall and access to irrigation water. Regional variations in yields also have been taken into account, and also in the output prices to farmers to some extent. Factor inputs and their prices have been considered standard for different crops and regions.

It is assumed that cleared agricultural land constitutes a source of livelihood for Afghans who otherwise lack a means to support themselves and their families, as jobless or substantially underemployed, receiving help either from friends and relatives or from international assistance agencies. (They could be living inside Afghanistan or as refugees in other countries.) In cost-benefit analysis it makes no difference whether refugees were actually working abroad, as conventionally benefit and cost calculations stop at the national border. In any case, return of refugees is considered to be an important goal in its own right by the assistance community for Afghanistan. For these reasons, no deduction has been made for the economic opportunity cost of farm labor input for agricultural production, as this input is assumed to have no alternative productive employment in general.

The agricultural practices in the case studies are assumed to represent typical patterns rather than recommended or ideal practice. It is not the actual (drought-affected) situation in Afghanistan today that should taken into account, but rather the conditions that could be expected to prevail with more normal weather and stable conditions. As is the case with other components of the cost-benefit analysis, the economic benefits from agricultural land are valued over a 15-year time horizon using a discount rate of 10% p.a.

The calculation method used for each of the eight case studies, with the results shown in Tables 6.6 to 6.13, can be briefly described as follows:

- The selection of crops is assumed to be typical for the region covered by each of the eight case studies.

- Information was gathered from different sources on yields in tons per km^2 area for different types of crops, and the average yield per km^2 of agricultural land is calculated on the basis of figures in FAO agricultural models. As expected, significant regional variations are found.
- The prices used in the calculation of gross revenue per km^2 are the market prices for May/June 2000, which are reported through FAO sub-offices from different regions. A certain degree of regional variation also is found in prices of agricultural products.
- Harvest yield times price gives the gross revenue of production from one km^2 of agricultural land. (This is not shown in Tables 6.6 to 6.13 but is the product of the first two columns in the tables.)
- In order to derive the net revenue per unit of land area, the value of non-factor inputs needs to be deducted. In Tables 6.6 to 6.13, this has been calculated as the amount of inputs required for the output of specific agricultural crops on one km^2 of land. In the case of irrigated wheat in Table 6.5, for example, it is estimated that US$ 10,700 worth of inputs is needed to produce 150 tons of output. Farm inputs include seeds, chemical fertilizers, manure, pesticides, and hired oxen or tractor draught power.

The use of fertilizer and chemical protection material and all other inputs is estimated according to availability of inputs, affordability for the farmers, and farmers' access to them. Hence the inputs recommended by the Ministry of Agriculture and FAO are much higher than the farm inputs estimated in this report. Irrigation cost has not been taken into account, because normally river or Karez (traditional underground irrigation channels) water is being used for irrigation purposes except in drought-affected areas. Management costs also are not taken into account, and neither is the farmers' daily use of farm products such as fruit, vegetables, or firewood.

- To estimate the cost of fertilizer inputs we consider the total active irrigated land and the amount of fertilizer distributed in the country. A total of 157,700 tons of fertilizer was distributed to farmers in 1986, while the active irrigated land was 26,000 km^2 in 1993. Assuming that fertilizer use remained constant during this period, the average use of fertilizer would be 6.1 tons per km^2. A bag of 50 kg white fertilizer (UREA) costs around US$ 16, so the estimated fertilizer cost per km^2 of farmland would be US$ 1,620.
- Usually oxen and tractors are used as power for cultivation of land. The cost of both types of power is on average roughly US$ 2000/ km^2.
- It has to be taken into account that the provinces covered by the case studies all have cropping intensities different from 1. This means that either more or less than one crop can be harvested each year. The intensity varies from 0.35 in Case 1 or about one crop in the course of 3 years, to 1.92 in case study IV, that is almost 2 crops a year normally.
- When the cropping intensity is lower than 1, it is assumed that land is available for grazing animals in years without agricultural planting. The annual forage value from a km^2 of land is assumed to be in line with the outputs for grazing areas, as described in section 8.
- The recent exchange rate of 1US$ = Afs. 60,000 has been used for converting monetary values of yield and farm inputs into US dollars.

In each of the Tables 6.6 to 6.13, the revenues for each type of crop (last column) is calculated in the following way: The harvest yield is multiplied by the output price and the cost of input factors is subtracted. The remaining net revenue is then multiplied by each crop's share (%) of land use and the cropping intensity specific for each Case Study region.

Table 6.5: Case Study I, Northern Region*
Annual Net Revenue from Agricultural Land, US$ per km²

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km²	US$/tonne	US$ per km²		US$
Irrigated wheat	150	252	10700	24 %	2 276
Rainfed wheat	94	250	5500	33 %	2 079
Barley	80	200	5000	17 %	655
Rice	186	500	8650	26 %	7 676
Grazing (remaining part of time)					1 349
Annual net revenue US$ per km² agricultural land					14 035
Cropping intensity		0.35			
Grazing time		0.65			

** The Northern Region consists of the provinces of Faryab, Jawzjan, Balkh, Samangan, Kunduz, Baghlan, Takhar, Badakhshan.*

Table 6.6: Case Study II, The Provinces of Parwan, Kabul, Kapisa.
Annual Net Revenue from Agricultural Land, US$ per km².

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	Tonnes/km²	US$/tonne	US$ per km²		US$
Irrigated wheat	189	252	10700	45 %	26 588
Maize	88	170	7050	15 %	1 898
Beans	175	670	8600	30 %	52 152
Forage crops	350	34	4850	10 %	1 128
Annual net revenue US$ per km² agricultural land					81 767
Cropping intensity		1.6			

Table 6.7: Case Study III, The Provinces of Logar, Wardak
Annual Net Revenue from Agricultural Land, US$ per km².

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km²	US$/tonne	US$ per km²		US$
Irrigated wheat	189	250	10700	30 %	15 132
Potato	2275	136	15950	15 %	60 744
Fruits	1750	240	8750	15 %	85 129
Forage crops	360	35	4850	35 %	3 743
Rice	175	250	8650	5 %	2 422
Annual net revenue US$ per km² agricultural land					167 170
Cropping intensity		1.38			

Table 6.8: Case Study IV, The Provinces of Nangarhar, Laghman, Kunar. Annual Net Revenue from Agricultural Land, US$ per km^2.

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km^2	US$/tonne	US$ per km^2		US$
Irrigated wheat	189	255	10700	28 %	20 157
Rice	350	450	8650	38 %	108 601
Forage crops	380	38	4850	34 %	6 260
Annual net revenue US$ per km^2 agricultural land					135 019
Cropping intensity		1.92			

Table 6.9: Case Study V, The Provinces of Kandahar, Zabul, Oruzgan. Annual Net Revenue from Agricultural Land, US$ per km^2.

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km^2	US$/tonne	US$ per km^2		US$
Irrigated wheat	175	250	10700	22 %	10 907
Pomegranates	2500	245	8750	18 %	163 013
Apples	1050	335	8750	10 %	51 450
Apricots	525	1 200	8750	10 %	93 188
Potato	588	140	15950	10 %	9 956
Forage crops	370	40	4850	30 %	4 478
Annual net revenue US$ per km^2 agricultural land					332 990
Cropping intensity		1.5			

Table 6.10: Case Study VI, The provinces of Ghazni, Paktika, Paktia. Annual net revenue from agricultural land, US$ per km^2

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km^2	US$/tonne	US$ per km^2		US$
Irrigated wheat	179	250	10700	73 %	19 140
Potato	1050	140	15950	5 %	5 045
Forage crops	3500	40	4850	22 %	22 894
Grazing					296
Annual net revenue US$ per km^2 agricultural land					47 375
Cropping intensity		0.77			
Grazing time		0.23			

Table 6.11: Case Study VII, The Provinces of Helmand Annual Net Revenue from Agricultural Land, US$ per km^2.

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km^2	US$/tonne	US$ per ^{km2}		US$
Irrigated wheat	220	245	10700	52 %	37 290
Cotton	140	400	7650	14 %	11 237
Maize	192	170	7050	17 %	7 221
Alfalfa	390	34	4850	5 %	698
Other	181	249	12592	12 %	6 450
Annual net revenue US$ per km^2 agricultural land					62 896
Cropping intensity		1.66			

Table 6.12: Case Study VIII, The Province of Herat, Badghis, Farah, Nimroz Annual Net Revenue from Agricultural Land, US$ per km^2

Crops	Harvest yield	Price	Input factors	Land use	Revenues
	tonnes/km^2	US$/tonne	US$ per km^2		US$
Irrigated wheat	189	235	10700	45 %	24 275
Maize	160	145	7050	12 %	3 101
Bean	155	520	8600	22 %	25 344
Clover	350	38	4850	12 %	1 622
Rainfed carabie	55	833	5900	9 %	5 748
Annual net revenue US$ per km^2 agricultural land					60 090
Cropping intensity		1.6			

In some areas of Afghanistan, opium poppy and cannabis have formed integral parts of the cropping pattern and have played an important role in the economy. Case studies IV, V and VII comprise districts that have been important poppy-growing areas. However, incomes from illicit crops appropriately are not included as benefits in this study. Before clearance of any agricultural land, the landowner is required to give a solemn promise not to cultivate any illicit crop on the cleared land and to sign a contract to this effect. Even more important, the Taliban authorities' ban on opium poppy cultivation by all accounts has been effective. If this ban remains in force and continues to be effectively enforced, concerns about use of de-mined agricultural land for poppy cultivation would be alleviated.

As in the case of other components of the cost-benefit analysis, a time horizon of 15 years has been used for the benefits from reclaimed agricultural land after mine clearance. Discounted at 10% p.a. over the whole period, the benefits gained during the early years will carry a large weight in the total net discounted value of benefits, whereas the benefits after 15 years will have relatively little importance.

The net annual value of agricultural production shows wide variations, from US$ 14,000 annually in the Northern Region (Case Study I) to over US$ 300,000 in the provinces of Kandahar, Zabul, and Oruzgan (Case Study V). The Total Value in Table 6.13, comprising annual values discounted over 15 years, will constitute one of the benefit components to be compared with the cost of clearing one km^2 of agricultural land.

Table 6.13: Agricultural Land, Net Output Value in US$ 1000 of Production from one km^2 Annually and Discounted over 15 Years at 10% Discount Rate

	Annual Value US$ 1000	Total Value US$ 1000 over 15 years
Case Study I	14	107
Case Study II	82	622
Case Study III	167	1 272
Case Study IV	135	1 027
Case Study V	333	2 533
Case Study VI	47	360
Case Study VII	63	478
Case Study VIII	60	457

7. Irrigation Systems Blocked by Mines

7.1 The Role of Irrigation in Afghanistan

The origin of irrigated agriculture in Afghanistan dates back more than 4,500 years, and irrigation systems remain vital for agricultural production. Between 85% and 90% of all crops are grown under irrigation. There are numerous different types of irrigation systems, depending on streams, canals, springs, karezes (traditional underground irrigation channels), and arhats (Persian wheels), depending on water availability and farm location. Irrigation systems can be divided into two main categories: traditional and modern, each sub-divided into a number of sub-types.

Traditional Irrigation Systems:

Arhat: Ground water is lifted from shallow wells with the help of a Persian wheel (Arhat), supplying irrigation water for the fields of an individual farmer. The size of the area irrigated by a single arhat does not exceed 0.03 km^2.

Karez (Qanat): This system is used in steep areas. Underground water is brought into free flow through tunnels from alluvial aquifers. Karezes are dug by local craftsmen as shafts at close intervals; they are usually narrow but may be many km in length. Discharge varies between 10 to 500 litres per second. The irrigated area is in the range of 1-2 km^2. Karez water can also be used for drinking water.

Small-scale traditional water systems are supplied by stream flow diverted with the help of temporary brush weirs. Often situated in remote valleys along a stream or river, they vary in size, irrigating up to 1 km^2. The villagers themselves are responsible for arrangements and maintenance.

Medium-scale traditional surface water systems are supplied by river flow diverted with the help of brush weirs, and can irrigate the agricultural land of several villages. Size can be from 1 to 20 km^2. They are operated by villagers in a similar way as small-scale or large scale irrigation systems.

Large-scale traditional surface water systems are supplied by river flow diverted with the help of temporary brush weirs. Extending over areas up to 2,000 km^2, they are located on flat plains and along the main valleys. Their operation and maintenance are highly structured and involve several communities, sometimes of different ethnic origins. Each village has at least one water master (Mirab), responsible for allocation of water to the different plots of the scheme.

Modern Irrigation Systems include:

- Modern surface water systems without storage;
- Modern surface water systems with storage;
- Modern ground water systems (using mechanical pumps driven by fossil fuels as electricity).

Cropping intensity varies widely from system to system depending on the availability of water in relation to land and also on climatic conditions. It can reach a level of two in the upper part of the irrigation schemes, while in the lower parts up to two-thirds of the area may be kept fallow each year on a rotational basis.

Table 7.1: Irrigated Land in Afghanistan by Type of Irrigation Source

Type of irrigation source	Streams and canals	Springs	Kareze	Arhat (Persian wheel)
Number	7822	5558	6741	8595
Area cultivated in km^2.	20180	1870	1670	120

Source: Afghan Agriculture in Figures, 1978

At present, more than two-thirds of Afghanistan's irrigation schemes are not operating satisfactorily. It is estimated that 10% of all irrigation systems in Afghanistan were directly affected by the war. More important ultimately have been the effects of neglect and abandonment. A principal reason for irrigation systems falling into disuse is landmines, which interferes with their use (although in the short run water flow may not be disrupted) and prevent routine and periodic maintenance (such as de-silting).

7.2 Economic Benefits from De-mining Irrigation Systems

A total area of eight km^2 of irrigation systems has been de-mined under the mine action program (as of the year 2000). According to MAPA assessments[1], 3.8 km^2 of high-priority irrigation systems remain to be cleared. Another 0.6 km^2 of mine infested irrigation systems have been identified and assigned lower priority.

Table 7.2: Mines in Irrigation Systems, km^2

Year	*1990-2000*	*1999*	*1998*	*1997*	*1996*	*1995*	*1994*
Cleared land km^2.	8.0	1.2	0.4	0.7	0.5	0.7	1.3
Remaining by 2000							
– high priority	3.8						
– other area	0.6						

Since irrigation systems provide water for agricultural use, the economic benefit from mine clearance is the resulting agricultural production. Therefore, the data used for analysis of mine clearance in agricultural areas in Section 6 will also be applied in the case of irrigation systems. The benefits to agriculture from clearance of irrigation systems will consist of the potential for expanded and improved use of the areas irrigated by the system. These areas are much larger than the actual extent of the irrigation system itself.

There is no fixed relationship between the size of a mined irrigation system and the area of land irrigated by that system, and large regional as well as local variations in this ratio may be expected. In fact, each sizeable irrigation system is likely to be different in this regard. From the MIS Socio-economic Database, examples of both very high (average 25 times) and smaller ratios can be found.

For the purpose of the cost-benefit analysis, the economic output from the agricultural land concerned after the irrigation system has been cleared of mines needs to be compared

[1] Source: MAPA Annual Workplan for Year 2000.

with the situation in the absence of mine clearance. Typically some of the agricultural land will also be mined. In these situations the entire benefit from increased agricultural production cannot be imputed only to the cleared irrigation system but must be shared with the clearance of the agricultural land concerned. In cases where the land served by the irrigation system is not mined, there may be potential for use while the irrigation system remains mined, even though output will be much lower than with irrigation water fully available. Use as grazing areas for animals, for example, should be possible. Some water may still pass through the irrigation canals, even though parts of them cannot be maintained because of mine contamination. The farmers may also have alternative sources for irrigation water, or diversion canals may have been made.

Based on these considerations, the actual benefits from clearance of an irrigation system would not always be the full production from the agricultural land it is serving. Thus a ratio needs to be assumed between the size of the benefit area and the area of the mined irrigation system. For the above-mentioned reasons this ratio will be set at a lower level than generally found in the MIS Socio-economic Database.

It is assumed that the irrigated area benefiting from clearance is three times the actual size of the mined irrigation system. The main reason for this low ratio is to take into account the likelihood that in cases of mined irrigation systems, agricultural areas in the same district also will be mined, implying that benefits will have to be shared. In Case Study I the agricultural benefits have been reduced by 10%, indicating that not all areas in that region are dependent on irrigation. Benefits from alternative use of the areas served by the irrigation systems for grazing animals have been deducted (the source of this data is Table 8.6).

The estimated total benefits from de-mining irrigation systems are shown in Table 7.3. Basic data for these calculations are the benefits from agricultural production in Table 6.13.

The benefits from clearing irrigation areas are substantial, as much as about US$ one million per year in the provinces of Case Study V. Total value discounted over 15 years is large in most cases and can justify substantial clearance costs.

Table 7.3: Benefits from De-mining Irrigation Systems, US$ 1,000 per km^2 Cleared Irrigation System, Annually and Discounted over 15 years

	Annual value	Total value discounted over 15 years
Case Study I	36	272
Case Study II	244	1 854
Case Study III	500	3 803
Case Study IV	404	3 069
Case Study V	997	7 584
Case Study VI	141	1 071
Case Study VII	187	1 422
Case Study VIII	178	1 356

8. Mine Infested Grazing Areas and Damage to Livestock

8.1 The Livestock Sector and its Contribution to the Afghan Economy

Livestock products contributed 16% to Afghanistan's GDP before 1978 and accounted for about 14% of the country's exports, while an additional 9% of exports came from livestock-related products, mainly carpets and rugs. In addition to their quantitative significance, livestock are a very important safety net for Afghan households. During the war large numbers of Afghanistan's livestock were destroyed together with other farm assets. Animals in significant numbers also moved out of Afghanistan with refugees.

The livestock population started increasing with the return of Afghan refugees from Pakistan and Iran in the early 1990s. Prior to the severe drought of the last two years, it was estimated that the number of cattle, horses and camels had returned to pre-war levels, while the number of sheep and goats had increased considerably. A World Bank study [1] estimates the livestock sector's contribution to Afghanistan's Gross Domestic Product (GDP) at US$ 508 million for 1998/99. The livestock sector appears to have grown at 2-4% per year from 1995 onwards. Unfortunately, however, the recent drought has hit Afghanistan's livestock very hard, and the majority of livestock have been sold, slaughtered, or died due to lack of water and forage. This damage will take time (and a return to better climatic conditions) to repair.

Table 8.1 shows the estimated number of different kinds of livestock in Afghanistan in 1998/99. It is based on FAO figures from 1995/96, assuming that the number of cattle increased at a rate of 2% annually, and sheep and goats by 3%, in the following years.

Table 8.1: Livestock Rearing in Afghanistan, Estimates for 1998/99 (Numbers in Thousands)

Cattle	3,919
Sheep	2,4051
Goats	9,758
Horses	389
Donkeys	1,081
Camels	294

Source: Role and size of livestock sector in Afghanistan, World Bank 2000

Livestock production in Afghanistan is mainly based on grazing, and 84% of the country can be classified as pastures or rangeland (Table 6.1). Livestock in the country seem to make maximum use of the existing rangelands as well as crop by-products.[2] About 40% of the areas are suitable for grazing during winter. In the higher elevations and mountainous areas with low temperatures and long snow cover, indoor feeding is practised during winter for all livestock, and in the uplands and northern Afghanistan for large ruminants only. In

[1] Source: Role and size of livestock sector in Afghanistan, World Bank 2000.
[2] FAO 1997: Afghanistan Agricultural Strategy, Livestock Production.

the southern and eastern parts of the country, livestock can be kept outdoors all year round because of the relatively warm climatic conditions.

The common pattern all over the country is for farmers to have more than one cow, but even the smallest and poorest farmers normally keep at least one cow. Dry cows, young stock, and males are usually sent to the hills during the summer. The community manages the cattle during this period. Sheep and goats are generally kept together and mainly graze outdoors for the greater part of the year. Sheep and goat flocks migrate from the lowlands to the highlands during summer. During winter and under severe weather conditions, sheep and goats are provided shelter and offered supplementary food – hay, straw and tree leaves. They are also occasionally fed on purchased concentrates. Nomads rear sheep and goats in large numbers.

The major products from cattle, goats, and sheep are food items, such as beef, mutton, milk, and other dairy products like cream, butter, curd, yoghurt, ghee and cheese, and also draught power, wool, hair, pelts, and hides. Production of Karakul pelts, for which Afghanistan had been famous, is estimated to have declined by 50% due to the non-existence of dealers and markets, despite a revival of the number of Karakul sheep.

Table 8.2: Prices of Livestock Products (1999)[3] and Sector Output (1995-96).[4]

	US$/kg	*Production*	*Unit*
Cow milk	0.21	680	1000 tons
Sheep and goat milk		620	---
Beef	0.93	43	---
Mutton	1.28	104	---
Wool		33	---
Hair		4	---
Cashmere		250	Tons
Karakul pelts		450	1000
Skins		450	---
Hides		6500	---

Livestock productivity in Afghanistan is relatively low. The volume of production of goat and sheep milk is almost on a level with cattle milk. Mutton constitutes a significant part of total meat production in Afghanistan. There are exports of cattle, sheep, and goats to Pakistan. All cashmere wool produced in the country is exported, as are about 80% of the karakul pelts.

Afghanistan can be divided into a number of agro-ecological zones (see Section 6), each with a different pattern of agricultural production and also with a distinctive pattern of livestock rearing, numbers and types of cattle per household, utilization of grazing areas, etc. The grazing season and the resulting need for supplementary fodder can vary widely with the length of the cold winter season and of dry periods. The different agro-climatic zones form the basis for the eight case studies for agriculture and livestock rearing in this report.

[3] Role and size of livestock sector in Afghanistan, World Bank 2000, page 10.
[4] FAO Livestock Office, Islamabad.

8.2 Economic Benefits from De-mining Grazing Areas

An area of 67.8 km^2 of grazing lands had been cleared under the mine action program by the year 2000. According to MAPA's assessment,[5] there remain 136.6 km^2 of high-priority grazing areas to be cleared. An additional 344.5 km^2 of lower-priority mine-infested grazing areas have been identified.

Table 8.3: Mine Infested Grazing Areas, km^2

Year	*1990-2000*	*1999*	*1998*	*1997*	*1996*	*1995*	*1994*
Cleared grazing areas	67.8	10.1	10.3	13.2	7.1	9.3	7.3
Remaining year 2000							
– high priority area	136.6						
– other grazing area	344.5						

A World Bank study has estimated the livestock sector's contribution to GDP in Afghanistan.[6] The basic data for this calculation is the number of livestock as presented in Table 8.1. The sector's product is composed of the value of its commodity outputs and of animal draught power. Price information for livestock products was obtained from major markets, and in order to estimate farmgate prices, current market prices were reduced by 10%. The value of draught power was estimated on the basis of the number of work animals, average number of days of work, and their feed and maintenance cost. It was also assumed that the value of draught power and other products constitutes 15% of the value of the livestock main products, (meat, milk, skin and hides). The number of work animals used in crop cultivation and for draught purposes was estimated at 14% of the cattle population.

For the calculations in this study, the value of draught power has been set at 9/10 and other by-products (bones, blood, fat, dung etc.) at 1/10 of the above mentioned 15%. The output of hides has been distributed on the basis of number of animals, taking into account that draught animal (horse, donkey, camel) normally will be kept much longer than cattle (estimated five times as long).

In the World Bank analysis of the livestock sector's contribution to GDP, the value of non-factor inputs has been deducted. Inputs for the livestock sector include green and dry fodder, concentrates, grazing from pastures and rangelands, medicines, and vaccines. It was estimated in the livestock study that this amounts to 15% of the total value of the livestock products.

The present analysis has a somewhat different focus. An assessment is needed of the contribution of grazing areas (pastures and rangelands) to the output of the livestock sector. First, it is assumed that the areas classified as potential grazing areas in the MAPA database generally have no alternative productive use other than for grazing animals. Animals can be sent there for grazing, or fodder can be collected from such lands for feeding animals indoors during the winter or in the dry season.

[5] Source: MAPA Annual Workplan for Year 2000.
[6] "Role and Size of Livestock Sector in Afghanistan", World Bank, 2000.

Fodder can also be collected on agricultural land, or purchased. The value of the fodder inputs not coming from the grazing areas in question should be deducted, but not for that period of the year when livestock can make use of grazing areas.

Medicines and vaccines for animals are seldom used to any significant degree in poor countries. Some NGOs have distributed livestock medicines in Afghanistan free of charge. In any case, diseases occur most frequently when animals are fed indoors and are obliged to live off a low-quality or unvarying diet, and not when they can roam freely outdoors and feed on a wider selection of plants.

In the present analysis, the 15% input cost estimated in the livestock study will therefore not be deducted from the gross value added of the livestock sector. The grazing areas' contribution to the output of the livestock sector instead is assumed to vary proportionally with the year that animals can be expected to find fodder on the grazing areas concerned.

Table 8.4: Net Output Value per Animal per Year (US$)

Cattle	51
Sheep and goats	9
Horses	31
Donkeys	31
Camels	31

Based on the above assumptions, estimates for net output value in US$ per animal per year were derived and are shown in Table 8.4. For cattle, the output value consists of the value of cow milk, meat, part of hides, part of draught power, and part of other products. For sheep and goats, the value of their meat, milk, wool, skin, hair, pelts and part of other products is aggregated. Horses, donkeys, and camels gain their output value from draught power, hides, and a proportional share of other products.

The level of productivity of Afghan pastures varies significantly between areas and from one year to another. FAO estimates average production on the country's pastures and rangelands (totalling 547,000 km^2) at 70 tons of fodder (as dry matter) per km^2 per year, and 50% utilization this fodder by livestock is assumed.[7] Given that the grazing areas cleared of mines under MAPA are all classified as high priority areas, it is reasonable to assume that they yield at least 50% more than the average. The degree of utilization also can be expected to be substantially higher than the average, since the high-priority grazing areas are supposedly located close to settlements. Assuming that the degree of utilization is 80% results in an estimated yield of 84 tons fodder (in dry matter) per km^2 of grazing area per year.

The number of livestock that can be sustained on this amount of fodder depends on the composition of the flock and the consumption of each type of animal. On the basis of FAO data, a cow consumes 2.6 tons of fodder annually (in dry material), and a sheep or goat

[7] FAO 1997: Afghanistan Agricultural Strategy, Livestock Production, page 19.

0.3 tons, while we have assumed that horses, donkeys, and camels consume the overall large livestock average of 3.1 tons.

The case studies comprise eight different patterns of livestock rearing in Afghanistan (see Table 8.5). All regions that are of interest in connection with mine clearance are covered. Livestock rearing practices vary considerably across the regional case studies.

Table 8.5: Livestock Practices, Number of Cattle per Household in Different Parts of Afghanistan

Case Study	Provinces, Regions	Cattle	Sheep and Goats	Horses, Donkeys, Camels
I	Northern Region all provinces*	7	230	6
II	Parwan, Kabul, Kapisa, Bamyan	4	3	1
III	Logar, Wardak,	3	3	1
IV	Nangarhar, Laghman, Kunar	3	2	1
V	Kandahar, Zabul, Oruzgan	1	3	0
VI	Ghazni, Paktika, Paktia	3	3	3
VII	Helmand	4	12	1
VIII	Heart, Badghis, Farah, Nimroz	3	25	1
Fodder consumption, tonnes per livestock/year		2.6	0.3	3.1

***** *The Northern Region consists of the provinces of Faryab, Jawzjan, Balkh, Samangan, Kunduz, Baghlan, Takhar, Badakhstan.*

The size of the livestock flock that can be sustained on the annual production of one km^2 of grazing area is then calculated, taking into account these regional variations. The flock in Case Study I can be supported on the grazing land concerned for only about nine months of the year, whereas in the other cases more livestock could be sustained for a whole year on the annual production from one km^2 of grazing areas than the flocks specified in Table 8.5. The flocks in each case study are therefore adjusted so as to consume a year's production from one km^2 exactly, while retaining the composition on livestock typical for the region concerned.

The resulting flock size is finally multiplied by the net output value per animal per year from Table 8.4 to derive the net annual output value from livestock rearing on one km^2 of grazing area (Table 8.6).

Table 8.6: Net Annual Output Value and Total, 15 Years Discounted Value from Livestock Rearing on one km^2 of Grazing Area (US$)

Case Study	Regions, provinces	Annual	Total 15 years
I	Northern Region all provinces*	2076	15791
II	Parwan, Kabul, Kapisa, Bamyan	1556	11834
III	Logar, Wardak	1500	11411
IV	Nangarhar, Laghman, Kunar	1500	11411
V	Kandahar, Zabul, Oruzgan	1905	14487
VI	Ghazni, Paktika, Paktia	1287	9788
VII	Helmand	1707	12986
VIII	Heart, Badghis, Farah, Nimroz	1932	14692

*The Northern Region consists of the provinces of Faryab, Jawzjan, Balkh, Samangan, Kunduz, Baghlan, Takhar, Badakhstan

The net output from a flock of livestock, typical for the Northern Region (Case Study I in table 8.6), consuming exactly the annual production from one km^2 of grazing area is estimated at US$ 2,076. This will constitute a part of the estimated economic benefit from livestock production when one km^2 of grazing area in this region is cleared of mines and UXO. Benefits of an equal value would be gained from that particular cleared area in future years as well. The total benefit is calculated as usual over a 15-year time horizon with a 10% annual discount rate.

As can be seen from Table 8.6, the productive economic benefit from grazing land varies much less across the regional case studies than does agricultural productivity. All but one of the case studies falls within the range of US$1,500-2,100 per year, with the remaining one at around US$1,300. For example, in the Northern Region the total future discounted benefits from livestock rearing on one km^2 of grazing area are estimated at over US$ 15,000, which, together with the other benefits from clearance of grazing areas, can be compared with the prevailing costs of mine clearance.

As in the case of agriculture, it is assumed that the grazing areas cleared of mines will essentially provide a means of living for people who otherwise would be sustained on aid from the international community or from work in other countries. It can thus be assumed that the labor power input for the livestock sector will have little opportunity cost.

8.3 Livestock Killed by Mines

Considerable numbers of livestock are lost in mine accidents. The Socio-economic Study (SEIS) found that a total of 242,100 animals were lost in the areas covered by the study, which correspond to the areas cleared of mines by MAPA during 1990-1998 (166 km^2). SEIS in addition assumed that these areas had remained active minefields and uncultivated for an average period of 10 years.

Table 8.7: Livestock Reported Killed by Mines During a 10 Years Period[8]

	SEIS Total
Cattle	83,500
Sheep, goats	155,400
Horses, donkeys, camels	3,200
Livestock killed by mines	242,100

A large number of mines must have been detonated in accidents killing livestock, even though more than one animal could have been killed in many of the explosions. Comparison can be made with the actual number of mines found during MAPA mine clearance operations – 210,000 on about 200 km^2 of minefields from 1990 until the end of 1999.

[8] Source: MCPA 1999 Socio-Economic Impact Study of Landmines and Mine Action Operations in Afghanistan, page 17.

From this comparison it could be concluded that as many as half of mines are inadvertently "cleared" by animals blowing them up. However, some exaggeration or double counting is suspected, and there is also the possibility that reports to the SEIS study of killed livestock cover significantly larger areas than the 166 km^2 designed as the SEIS study area. The extent of such areas is unknown, but conceivably they could include all mined areas in the districts the SEIS covers. Little other information is available on numbers of animals killed in mine accidents.

It can be assumed that few livestock accidents occur in mined residential areas and irrigation systems. The number of accidents where animals are killed will therefore be associated with mined agricultural areas, grazing areas, and roads. It is conservatively assumed that the mined areas causing accidents where animals are killed are roughly five times as large as the SEIS study areas, also including low-priority areas in the district. This gives an accident rate of 36 killed animals annually per km^2 of mined area.

Table 8.8: Risk of Livestock Loss Annually per km^2 of Mined Land

	Animals killed	Cattle	Sheep, goats	Horses, donkeys, Camels
Agricultural land	36	12	23	0.5
Roads	36	12	23	0.5
Grazing areas	36	12	23	0.5
Value US$ per animal		200	40	220

The proportion of the different types of livestock killed on each type of land is assumed to be the same as for all livestock killed. We have no information about differences in risks to livestock per km^2 of mined agricultural land versus roads or grazing areas. Regional variations, for example on the basis of patterns of livestock holding from the case studies, have not been introduced at this stage. The source for livestock sales prices is the SEIS study.[9] It should be possible to retain meat value from wounded livestock in some cases, so 30% of the estimated economic loss on this account is subtracted.

When a minefield remains active and uncleared, animals will continue to be killed in future years. Still, it would be logical that the accident risk is reduced over time as mines are exploded. It is therefore assumed that the accident risk decreases by 5% annually over the period.

The annual and total economic values from loss of livestock (shown in Table 8.9) constitute benefit components to be included in estimated total benefits, which are then compared with the cost of mine clearance.

[9] Source: MCPA 1999 Socio-Economic Impact Study of Landmines and Mine Action Operations in Afghanistan, page 17.

Table 8.9: Economic Loss of Livestock per km^2 of Mined Areas, US$ Annual Loss and Total Loss Discounted over 15 Years at 10% Discount Rate

	Annual	***Total****
Agricultural land	2441	14467
Roads	2441	14467
Grazing areas	2441	14467

** An annual 5% reduction in accident rate over the 15 years is assumed.*

9. Roads and Transportation Systems Blocked by Mines

9.1 The Transportation System in Afghanistan

Roads constitute the backbone of the transportation network in landlocked Afghanistan. The total length of all roads in the country was estimated at about 17,000 km in 1978, of which 2,700 km were paved roads. No railways exist in the country, although lines have been built all the way to the border in Pakistan, Turkmenistan, and Uzbekistan.

Table 9.1: Road system in Afghanistan 1978

	km
Paved roads	2,700
Gravel roads	4,300
Tracks and dirt roads	10,000
Total	17,000

The principal agricultural areas and major population centers are linked by roads which cut through the Hindu Kush mountains in the central part of the country, connecting Kabul in the east with Baghlan and Mazar-i-Sharif in the north, Kandahar in the south, and Herat in the west. Distribution of food from surplus to deficit areas has always been an important transport task. Deterioration of the road network from war activities, general lack of maintenance, and closure of principal roads by mines has in certain periods contributed to higher food prices.

9.2 Economic Benefits from Clearing Roads of Mines

In the MAPA database, mine-contaminated road areas have been registered in terms of km^2 to correspond with other mined areas. It is assumed that road areas infested with mines are 20 m wide on average. The 27.9 km^2 of road area that has been cleared thus would correspond to 1,395 km of road length.

Table 9.2: Roads Blocked by Mines

Year	1990-2000	1999	1998	1997	1996	1995	1994
Cleared km^2.	27.9	2.1	5.3	4.1	3.2	2.4	2.5
Cleared roads km	1,395	105	265	205	160	120	125
Remaining by 2000							
– high priority km	1,605						
– other roads km	391						

MAPA estimates[1] indicate that a total length of 1,605 km of high-priority roads remain to be cleared. Another 391 km of mined roads have been identified but assigned lower priority.

[1] Source: MAPA Survey Database.

Some basic data are available from the MAPA socio-economic database on road transport in Afghanistan. In the survey connected to the SEIS study, data were collected from 524 cleared high-priority minefields classified as roads. At the time of the survey, these roads were all cleared and in use. The data are the best available but nevertheless may be distorted. For example, many entries with value "0" are suspected to be "no reply" rather than the value 0, which can distort calculation of averages.

On the assumption that traffic could make use of other routes or diversions before mine clearance, questions about reduced travel distance, saved travel time, and saved travel cost were asked in the survey. In Table 9.3 this information has been used to calculate some key indicators for road transport:

- Saved road transport distance in km per km of road cleared of mines (Saved km/km road).
- Vehicle speed in km per hour (Km/hour).
- Passengers transported per vehicle (Pass/vehicle).
- Passenger travel cost in US cents per km road (Travel cost USc/km).

Information was also collected on traffic and on vehicles per day on the road. For the purposes of the cost-benefit analysis, each vehicle is considered as a small business, where the passenger fares (passenger travel costs) cover all operational and capital costs.

Table 9.3: Road Transport in Afghanistan

	Province	Roads no	Roads km	Saved km	Saved km/ km road	Vehicles/ day	Km/hour	Pass/ vehicle	Travel cost USc/km
Case Study IX	Kandahar, Laghman, Kabul	141	946	434	0.5	622	15	2.6	2.9
Case Study X	Other provinces	383	841	1480	1.8	32	11	8.2	3.9
	Total/average	524	1786	1914	1.1	191	12	3.3	3.7

Source: MAPA Socio-economic Database

Data for the 524 former minefields can be aggregated on a provincial basis, and a further aggregation of provinces into two stylised case studies has been made on the basis of variations in traffic volume. Case Study IX comprises three provinces within or around the largest towns in Afghanistan, the capital Kabul and Kandahar. Road traffic is heavy in these localities – over 600 vehicles per day. On the other hand, saved km of road per km cleared is less than the average. Traffic can move somewhat faster by 15 km per hour, presumably due to better roads. There are comparatively few passengers in each vehicle, and travel cost is less than the average, which indicates a larger share of short-distance journeys. Case Study X, comprising all other provinces, shows the opposite characteristics. There is much less traffic on the roads, an average of only 32 vehicles per day. A higher road transport distance is saved per km cleared, however, and each vehicle carries many passengers. These characteristics distinguish Case Study X from the more urban areas represented by Case Study IX.

The information in Table 9.3 has been collected after the areas have been cleared of mines. In order to calculate the benefits for road traffic from mine clearance, information is also needed about the before situation, in particular the level of road traffic in a situation when a longer and more time-demanding and costly distance had to be travelled. It will be assumed that road transport demand in Afghanistan is relatively inelastic, with an elasticity of 0.5. A 10% travel cost decrease would lead to an increase in road traffic of 5%. This may be the situation when traffic to a large degree consists of work and other essential journeys.

The length of road used for analysis is 50 km, corresponding to 1 km^2 of mined land when the road is 20 m wide. The purpose is to convert all costs calculated into costs per km^2 of mined areas.

It is necessary to assume that the road distance travelled after clearance consists of the cleared road only, which may be wrong. Other stretches of not previously mined roads could be included, but we have no information about this. Moreover, as noted earlier, the information on saved road lengths in the database may contain inaccuracies. The material consists of many entries with 0 km saved (which could mean no information available rather than zero survey) and a smaller number of entries with large savings.

Employed persons are assumed to earn 1 US$ a day, which constitutes the basis for valuing their travel time. Unemployed and non-active persons may also value prolonged travel time negatively, so one-quarter of the cost for an employed person will be adopted as an estimate. Unemployment is assumed to be 50% of persons in the active age group 20-65 years. This age group constitutes 44% of the total population.

By applying these assumptions, it is calculated that travel costs on previously mined roads have decreased by 30% in the mainly urban areas included in Case Study IX, and by 60% in the areas of Case Study X. This would have caused increases in road traffic of 15% and 30% respectively, with the assumed elasticity of 0.5.

Traffic after clearance is set at 450 and 25 vehicles per day, respectively, for the two case studies. Some of the counted traffic may be strictly local and very short distance, in which the cleared road link does not necessarily play an important part.

Table 9.4: Travel Cost per Passenger and Traffics on Links of Road, Before and After Mine Clearance

	Case Study IX	*Case Study X*
Travel cost decrease %	30 %	60 %
Elasticity	0.5	0.5
Traffic increase	15 %	30 %
Traffic before clearance, vehicles per day	383	21
Traffic after clearance vehicles per day	450	25

The benefits from clearing mined roads are calculated as cost savings for passengers now travelling with vehicles on the safe road link as compared to the longer alternative route, which had to be used before clearance. The savings will comprise reduced direct travel costs or fares paid by passengers, which are assumed to fully cover the vehicle operating costs. In addition, the reduction in passengers' travel time has been evaluated, as explained above.

The passengers and vehicles that used to travel the longer alternative road link before clearance will draw full benefits from time and cost savings. In addition, some new traffic will be generated as a direct consequence of the drop in travel cost and time after reopening of the shorter road link. The benefits for this new traffic can be roughly estimated at half the amount of savings in travel cost and time.

The justification for this estimate is that all new travellers in theory could be ranked by their willingness-to-pay for trips they undertake. It would then be found that some of the new travellers are barely willing to pay even the new, reduced costs or take on the reduced travel time, while others would almost be willing to pay the cost and spend the travel time necessary for the longer journey before clearance. A good estimate of average willingness to pay for all new travellers together would thus be half way between the new and the previous costs. Their willingness to pay minus what they actually have to pay for the journey then constitutes the benefits for these new travellers. Benefits for new traffic thus amount to the number of new travellers multiplied by half the value of time and cost savings.

As would be expected, the benefits from clearance of mined roads are large, over US$ 250,000 per year both for urban areas (Case Study IX) and more rural regions (Case Study X). Different characteristics between the two case studies are largely offsetting in terms of the benefit calculations, so the total savings appear to be of much the same order. The lower traffic on rural roads is compensated for by the larger road transport distance saved per km cleared and the larger number of passengers carried by each vehicle as compared to the corresponding figures in the more urban areas. The annual benefits and the total benefits discounted over 15 years with a 10% discount rate (Table 9.5) form benefit components to be compared with the costs of mine clearance in road areas.

Table 9.5: Benefits from Clearance of Mined Roads, 1000 US$ Annually and Discounted at 10% Rate over 15 Years (for 50 km Roads=1 km^2)

	Case Study IX	Case Study X
Existing traffic, savings US$/year		
- Travel cost	237	215
- Travel time valued	29	25
New traffic, savings US$/year		
- Travel cost	21	19
- Travel time valued	3	2
Annual benefits all passengers US$ 1000	290	261
Total benefits over 15 years, US$ 1000	2 207	1 983

10. Mines in Residential Areas

It has been estimated that access to 87,500 houses has been blocked by landmines, constituting a major obstacle to the return of refugees and internally displaced persons to their villages. A rapid assessment in six districts of Afghanistan in October 2000 showed that close to 40% of all houses had been destroyed by war activities, and only some 30% remained undamaged. The traditional Afghan homestead, the qala, is used for residential purposes and for storing of agricultural products. Parts of it can also be used for keeping animals.

Estimating the average area of an Afghan family homestead (a Qala) at 500 m^2, means that access to about 55,400 houses has been cleared of mines during the period 1990-2000 (Table 10.1). According to MAPA's assessment[1], 27,400 high-priority residential units still remain to be cleared as of the year 2000. Another 250 mined residences were identified and given lower priority.

Table 10.1: Residential Areas Blocked by Mines

Year	*1990-2000*	*1999*	*1998*	*1997*	*1996*	*1995*	*1994*
Cleared land km^2.	27.7	3.1	3.4	2.8	2.7	4.9	2.9
Houses cleared	55400	6200	6800	5600	5400	98000	5800
Remaining by 2000							
– high priority	27400						
– other houses	250						

The structures cleared of mines under MAPA include private homes as well as public facilities such as schools, health clinics, hospitals, and government and administration offices.

Information on property prices was collected from different locations in Afghanistan during fieldwork in October 2000. The material is far from complete, and it shows some variation in prices, which would be expected. Kabul comes out as the most expensive area, with other eastern provinces somewhat below. Logar, a rural area to the south of Kabul, has the lowest property prices among the areas where information was gathered.

It was found during the fieldwork that a number of cleared housing areas were only partially in use or had not been reclaimed at all. The explanation given was often that the owner could not afford to meet the cost of reconstruction. In some cases the owner still lived as a refugee abroad. These observations suggest a need for more comprehensive information collection before priority is given to clearance of residential areas, as clearance techniques for standing or collapsed building structures tend to be expensive (see Section 11). More information on prices and rents for property also is needed. A presumably conservative estimate of benefits from clearance of residential areas is derived in the meantime.

[1] Source: MAPA Survey Database.

This limited material available provides the basis for two case studies on property values. Case Study XI includes provinces with the major towns of Afghanistan, where property values are assumed to be high, while Case Study XII comprises the remaining provinces of the country. The estimates in Table 10.2 are intended to reflect land values for high-priority residential areas for mine clearance by MAPA.

Table 10.2: Property Land Values in Afghanistan, US$ per m^2 or US$ million per km^2

	Province	*US$/$m^2$*
Case Study XI	Kabul, Kandahar	5
Case Study XII	Provinces except XI	2

11. Clearance Operations and Costs

The estimation of the costs of de-mining activities raises issues that are rather different from the issues that arose in the calculation of socio-economic benefits, as discussed in Sections 6-10. In principle the data problems are much more manageable, since the costs are incurred by the mine action NGOs, and extensive data on costs is compiled by MACA. However, there is some degree of incompleteness in the cost data, mainly relating to (1) the direct funding of some NGOs by donors outside of the UNOCHA Afghanistan Emergency Trust Fund, not all of the information on which is pulled together by MACA, and (2) in-kind contributions (e.g. vehicles, machinery, etc.) and their valuation. Overhead costs also need to be included. And finally, costs need to be allocated across different categories of land cleared and different types of de-mining techniques.

11.1 Program Financing and Cost Information

MAPA is financed from two main sources. Most funding from donors is channelled through the UNOCHA Afghan Emergency Trust Fund (AETF), which then distributes the funds by activities and to different NGOs. A much smaller but significant amount of funds is passed from donors directly to individual NGOs, which avoids paying the fixed 13% charge designed to cover UNOCHA overhead costs.

The amount of funds passed on directly to some NGOs is still only partially known to MAPA. It is, however, possible to separate out the clearance tasks undertaken with UNOCHA/AETF funds. For 1999 this appears to be 85% of the total mined areas cleared under MAPA and 54% of the former battlefield areas.

Some contributions, both through and outside the AETF, are made by donors in kind, including equipment, technical assistance, training, etc. The real value to the mine action program of these contributions can be difficult to assess. Most of them are purchased in high-cost countries at elevated prices, while MAPA in an untied situation could probably have found more economical options.

The information on MAPA funding as it appears in its Annual Reports therefore needs to be corrected in order to estimate the actual costs of the program. This study relies mainly on information about other financing supplied to MACA by the NGOs, which may nevertheless be incomplete.

For the NGOs engaged in mine clearance, it is clear which parts of their activities are financed through the AETF. On that basis a split of activities has been made in order to correct the estimates of unit costs, like cost per clearance team hour and cost per km^2 cleared.

A number of factors are considered important for the cost of mine clearance. The following information can be obtained from the MAPA Minefield Database:

- Size of area to be cleared.

- Minefield or former battlefields.
- Types of mined area: agricultural, residential, road, irrigation system, grazing land (former battlefields are not classified as to type of area).
- Surface of soil in area.
- Clearing techniques applied: manual teams, mine dog teams, mechanical teams (currently back-hoe), community-based clearance.
- Number of mines and UXO detected (known only after clearance is completed).

Minefields and former battlefields are cleared by teams using various techniques. The mechanical option consists of back-hoes, but other machines have been applied previously and new ones are about to be tried. Each technique implies a different composition of the clearance team in terms of manpower and equipment. One of the NGOs, AREA, is engaged in community based mine clearance as a pilot project.

Cost data for 1999, the latest available at the time of this study, have been used. The main source of information is the MAPA Annual Report, which presents information both on funding through the AETF and distribution of funds by agency (NGO) and activity. Corresponding information is also presented in the Annual Report for 1998, while earlier annual reports from MAPA contain less detailed information on costs. For detailed cost information on earlier years, MACA archives and the individual NGOs will have to be consulted.

Statistics on areas cleared in km^2 for different types of mined land also are presented in the Annual Report, the source of these data being the MAPA Minefields Database. Information on clearance team hours has been found most useful for the unit cost calculations. The NGOs register the number of hours spent by each of their teams (manual, mechanical, dogs) on individual clearance tasks. This information is entered into the MAPA Minefields Database. For the most recent years such data are complete, whereas not all NGOs supplied satisfactory data for earlier years.

11.2 Productivity of Operations

Information on area in m^2 and clearance time in team hours for each individual minefield and battlefield is available in the MAPA Minefield Database. The area in m^2 cleared per team hour provides an indication of clearance productivity. (For the year 2000 the months from January to July are included.)

From Table 11.1 it appears that the area of minefields cleared per team hour of work has decreased over time, from 464 m^2 in 1994 to 267 m^2 in 1999. One explanation for this could be that the tasks are getting more difficult as the easier areas were cleared first. Another possibility is that improvements in safety have been achieved at some cost in terms of speed of clearance operations. Generally it is much more time-consuming to clear minefields than former battlefields. On average during the period 1993-2000, about 20 times more battlefields than minefields were cleared per team hour of work.

Table 11.1: Clearance Productivity in m^2 Cleared per Team Hour

All areas and techniques	1993-2000	1999	1998	1997	1996	1995	1994
Minefield m^2/team hour	314	267	299	297	337	413	464
Battlefield m^2/team hour	6168	6307	4355	6154	6564	5585	20284
Battle-/minefield ratio	20	24	15	21	20	14	44

Minefields are classified by land types when the areas are surveyed. Distinctive variations appear in clearance efficiency for various types of areas, as can be seen from Table 11.2. Agricultural land comes close to the average in m^2 cleared per team hour for the period 1993-2000 in total (last column in Table 11.2). Grazing areas are normally much less time-consuming to clear, and this has also been the case with roads most of the time. Residential areas are far more time consuming to clear than the average. Clearance tasks on grazing land and in residential areas have both experienced significant drops in output per team hour over time.

Table 11.2: Clearance Productivity for Different Land Types, m^2 Cleared per Team Hour

All techniques	1993-2000	1999	1998	1997	1996	1995	1994	1993-2000
Land type:								Average=1
Agricultural land	343	299	392	368	354	351	481	1.1
Grazing area	519	361	491	604	478	720	989	1.7
Residential areas	123	93	71	67	146	285	243	0.4
Roads	470	532	759	486	741	457	292	1.5
Irrigation system	258	295	262	174	139	192	492	0.8
Average mined area	314	267	299	297	337	413	464	1.0

Turning to the productivity of different types of de-mining techniques, manual teams work on all types of land. Dog teams, which also include de-miners to extract the mines, started operations in 1994. Mechanical back-hoe techniques are used in particular where layers of rubble, ruins of houses, or heavy earth cover the mines, making manual excavation dangerous or impossible.

One important conclusion that can be drawn from Table 11.3 is that clearing minefields by means of dogs on average has been 3.5 times as efficient as manual teams in terms of m^2 cleared per team hour. Dogs are actually more efficient in all types of areas than both manual and back-hoe techniques. Nevertheless, specialized teams may be needed on certain types of land. Dogs can be used on open land with free visibility where trees or bushes do not hamper operations. The back-hoe is the least efficient method and is used exclusively when other techniques are dangerous or impossible. Flail has proved efficient on certain types of areas, but technical difficulties have been experienced. In certain areas, use of dogs faces seasonal restrictions because of sandstorms. For former battlefields, manual techniques are used almost exclusively.

Table 11.3: Productivity for Clearance Techniques on Land Types, Ratios Between m^2 Cleared per Team Hour Average for Manual Clearance of Mined Area is Here Set Equal to 1

Period 1990-2000	Manual	Dogs	Backhoe	Flail
Land type:				
Agricultural land	1.0	4.0	0.1	1.8
Grazing area	2.0	4.0	0.1	3.8
Residential areas	0.5	2.7	0.1	3.3
Roads	0.8	2.9	0.2	0.3
Irrigation system	1.0	3.4	0.4	
Average mined area	1.0	3.5	0.1	1.4
Battlefield	27	58		

The efficiency of mine clearing operations has changed over time. Therefore, the average for recent years including 1998, 1999 and January-July 2000 of m^2 cleared per team hour will be used for the cost calculations (see Table 11.4). Three techniques will be costed, manual teams, dog teams, and backhoe. Flail has been little used in recent years.

Table 11.4: Areas Cleared in m^2 per Team Hour, Average for the Period 1998-2000.

Land type:	Manual	Dogs	Backhoe
Agricultural land	156	918	68
Grazing area	330	802	30
Residential areas	60	637	23
Roads	129	691	53
Irrigation system	204	785	79
All mined areas	169	817	39
Battlefield	6036		

In Table 11.4 the area cleared in m^2 per team hour is shown for all techniques. In practice, as mentioned above, there are technical and economic restraints on the use of different techniques. Mined areas cleared in the period 1998-1999 and until the end of July 2000, distributed in percentage terms by techniques and types of land, are shown in Table 11.5.

Table 11.5: Mined Areas Cleared in the Period 1998-2000, Distributed in Percentage on Techniques and Types of Land

Land type %:	Manual %	Dogs %	Backhoe %	All techniques %
Agricultural land	18.4	27.1	0.27	46
Grazing area	23.9	7.4	0.08	31
Residential areas	5.5	3.4	0.24	9
Roads	0.3	10.0	0.00	10
Irrigation system	1.4	1.5	0.20	3
All mined areas	50	49	1,1	100

Manual teams (50%) and dogs (49%) have become the main techniques used in mine clearance activities conducted by MAPA. Clearance of roads is almost exclusively carried out by dogs, and this has also become the most frequently used technique on agricultural land. Manual clearance is still the main method used for grazing areas, and close to 100% of all former battlefields (not included in the table) are cleared manually.

The back-hoe is applied on a small scale for specific tasks in residential areas, for irrigation systems, and on agricultural land. It has only incidentally (1998-2000) been used for clearing other land types. Back-hoe teams are normally supported by manual teams, and it is difficult, often impossible, to make a clear-cut separation between mechanical and manual activities.

11.3 Clearance Costs

In Table 4.1, MAPA's unit cost of mine clearance was derived by dividing the annual cost of MAPA by the area of minefields cleared. For 1999, the costs calculated in this way amounted to US$ 0.6 per m^2 or US$ 600.000 per km^2. This cost figure needs to be adjusted, however, for several reasons:

- MAPA undertakes other activities in addition to mine clearance. Monitoring, evaluation, training, and minefield surveys are preparation for and thus integral components of mine and UXO clearance, so their inclusion in the total cost of mine clearance is well-justified. Mine awareness and advocacy for a ban on the use of landmines are separate activities, however, and their costs need to be excluded. Mine awareness is the most costly of these components. MAPA has allocated about 7% of its total budget for mine awareness purposes in 2000. Some NGOs are engaged in both mine clearance and mine awareness, but it is possible to separate these activities in the MAPA funding data.
- Clearance activities comprise former battlefields in addition to minefields. In 1999, about 75 km^2 of former battlefields were cleared as against 34 km^2 of minefields. Table 11.4 indicates that manual teams can clear more than 30 times as much former battlefield area of UXO per hour than mine-infested land. This suggests that minefields are about 30 times as costly to clear (using manual techniques) as former battlefields (which are almost invariably cleared manually).
- As discussed earlier in Section 11.1, the funds supplied directly to NGOs by donors need to be added to the AETF financing. In cases where information about additional funding is lacking, clearance tasks not funded through AETF should be deducted from the MAPA activity list, so that costs and activities correspond. However, questions may be raised whether contributions in kind are included fully and correctly.
- Investment expenditures need to be properly treated. The UNOCHA logistics and procurement section provides support to the mine action NGOs, including procurement of capital goods. Where non-expendable equipment is supplied, such as vehicles, communications equipment, and the like, costs should not be attributed to the year of supply only but rather treated as investments, subject to depreciation over a number of years depending on the normal useful lifetime of the item. Depreciation charges against investments undertaken in earlier years also should be included as expenses for 1999.

The cost calculations in this study are based on the table "AETF expenditure breakdown by agency and activity" from the MAPA Annual Report for 1999. This table gives expenditure for each agency. The agencies involved in mine clearance activities in that year were the following:

- ATC (manual and mechanical teams).
- AREA (manual, community based).
- DAFA (manual and mechanical teams).
- OMAR (manual and mechanical teams).
- MDC (dogs)
- HALO (manual and mechanical teams, survey).
- MCPA (survey, some manual clearance).
- META (training and monitoring).
- DDG (this agency started operations on a small scale in year 2000).

Only a few of these NGOs are, however, competing for the same types of tasks, so the potential benefits of competition may not be realized to any great extent.

AREA is engaged in a pilot community-based mine clearance program. Utilizing the local communities' human resources and know-how, the program enables ex-resistance fighters and other villagers to participate in mine clearance activities. The community-based mine clearance program is unique in the world. It is low cost, and payment to village de-miners is in the form of food-for-work or a nominal salary. There are few logistical costs, as the de-miners do not work outside their villages and can return to their homes at night. Technical and safety issues are potential problems, but no incidents were reported in 1999. The project has been assigned to work in low-priority areas only, on fields not containing anti-tank or minimum metal mines. The program started in 1997 and is still being operated on a small scale, clearing less than 0.5 km^2 of minefields annually (0.38 km^2 in 1999).

In 1999 OMAR cleared 3.48 km^2 of minefields. This NGO did not receive funding from UNOCHA/AETF for mine clearance, only for mine awareness. Information is, however, available on direct funding of OMAR from other sources, i.e. the European Commission, Netherlands Organization for International Development and Cooperation (NOVIB) and Germany. OMAR is using de-miners from local villages, so extra subsistence costs for out-of-station work are avoided.

HALO is engaged in surveying as well as mine and battlefield clearance. In 1999 this agency cleared 3.6 km^2 of minefields and 51.6 km^2 of former battlefields. HALO is working in the districts of Kabul, Baghlan, and Wardak on designated areas where they do both survey and clearance operations. HALO is self-sufficient in terms of training, and also does not pay a subsistence allowance since recruitment of people is from the area in which operations are ongoing. HALO (and DDG) apply working procedures which are to some extent different from those of MAPA.

In 1999 HALO received funding from the USA through UNOCHA/AETF for clearance and survey activities in Wardak Province, which is included in the MAPA Annual Report for 1999. With these funds HALO cleared 1.7 km^2 of minefields and 17.2 km^2 of former battlefields. The amount of funds HALO receives directly from donors for its other clearance activities is not known.

MDC uses mine dog teams exclusively. Since no other NGO is working with dogs, MDC costs give a complete picture of mine dog clearance costs in Afghanistan. MDC is also assisting MCPA on survey tasks with mine dog sets. The costs of operating these mine dog sets (about US$ 905,000 in 1999) have therefore been deducted from MDC's clearance activities and added to MCPA survey activities. Since the start of its activities in 1994, MDC has received support from the German government, some of it in kind.

MCPA's principal activity is the survey of minefields and former battlefields. Some mine clearance also is undertaken, mainly as part of survey activities. In 1999, 0.3 km^2 of minefields and another 0.3 km^2 of former battlefields were cleared by MCPA.

For the purposes of this study, all MCPA activities are regarded as integral to the mine and battlefield clearance activities of MAPA. MCPA survey costs have thus been added to the clearance costs of other agencies on a per km^2 basis. An exception is made for HALO, which is undertaking its own surveys.

META is in charge of training and surveying for the other mine action NGOs. The budget of this organization is added to the costs of the clearance and surveying agencies on a per team hour basis, except in the case of HALO which conducts its own training.

For each of the agencies listed above, the UNOCHA AETF funding has been increased by 13%, corresponding to the fixed UNOCHA overhead rate, to cover administration at MACA and other overhead costs. (All UNOCHA funding, including funds for activities other than mine action, carries an overhead charge of 13% to cover general overhead costs associated with operating in Afghanistan.) Direct/in kind contributions are assigned to the NGOs on the basis of team hours of work performed.

A tentative correction for depreciation is undertaken by assuming that the equipment supplied in 1999 (as per the Annual Report) will be depreciated over five years. An addition for equipment supplied in earlier years also has been made. ATC received a large supply of equipment in 1999 compared to the agency's total budget. Lacking more precise information, it is assumed that this new equipment replaced 50% of ATC's total capital stock. Other agencies received much smaller amounts of equipment, which are assumed to constitute 10% of their total capital stock. This estimate of depreciation is only preliminary, and the depreciation calculations should be revised when better information becomes available.

Table 11.6 shows the estimated cost of clearance in US$ per team hour resulting from the assumptions made above. Team hours are the best available basis for distribution of costs, better than per km^2 cleared, since productivity in terms of area cleared varies considerably with type of area, technique, and over time. Team hours are assumed to vary principally with clearance technique employed.

Table 11.6: Clearance Cost in US$ per Team Hour, Agencies 1999

	Manual-Mechanical	Manual/ community	Manual-mechanical	Manual-mechanical	Dogs	Manual-mechanical
	ATC	AREA	DAFA	OMAR	MDC	HALO
Cost per Team Hour	188	60	208	205	157	96

MDC is quite efficient in terms of cost per team hour worked. Moreover, mine dog clearance is more effective in m^2 cleared per team hour than all other techniques (see Table 11.4). It can therefore be stated that mine dog teams should be the first choice for all tasks where this technique is technically feasible.

ATC, DAFA, and OMAR come out with comparatively similar costs per team hour, in the range of US$ 188-208. All three agencies operate with both manual and mechanical teams.

At DAFA and OMAR, the mechanical teams (using back-hoes) work in an integrated way with manual teams. Therefore, their operations cannot easily be subdivided between these two techniques. In ATC, manual and mechanical clearance methods can be separated, since these operations are carried out by different teams. Efforts to calculate the costs of different clearance techniques will therefore be pursued using the cost data for this agency.

HALO's operations seem to be very cost efficient, and their figures even include the cost of surveying, which have to be added for the other agencies (calculated on a per km^2 basis). HALO's costs of US$ 96 per team hour are extraordinarily low, taking into account the fact that they are operating in a similar manner to ATC, DAFA, and OMAR. It is therefore appropriate to ask to what extent all of HALO's costs, for instance overheads, are included for the clearance tasks undertaken with UNOCHA/AETF funds.

The community-based approach seems cost efficient, but it is still rather early to draw very strong conclusions about it, since AREA is operating a pilot project on a very much smaller scale than the others.

As mentioned earlier, there is a need to separate manual and mechanical clearance costs. This has been achieved by means of detailed analysis of the costs of ATC, where such a split is feasible. It was found that manual methods in general are 1.5 times more expensive per team hour than mechanical methods (Table 11.7). Personnel costs are twice as high for manual teams, while capital and maintenance costs are not a great deal lower, in spite of the expensive back-hoe machine used by the mechanical team (cost US$ 134,000).

It seems that the actual cost of mine clearance by manual and mechanical teams can explain 56% of ATC's cost level, UNOCHA overhead costs and META services form another 15%. The remaining 29% can be considered agency overhead (see Annex 2 for detailed calculations of clearance costs).

Table 11.7: Manual versus Mechanical Clearance Methods, Cost Ratio per Team Hour

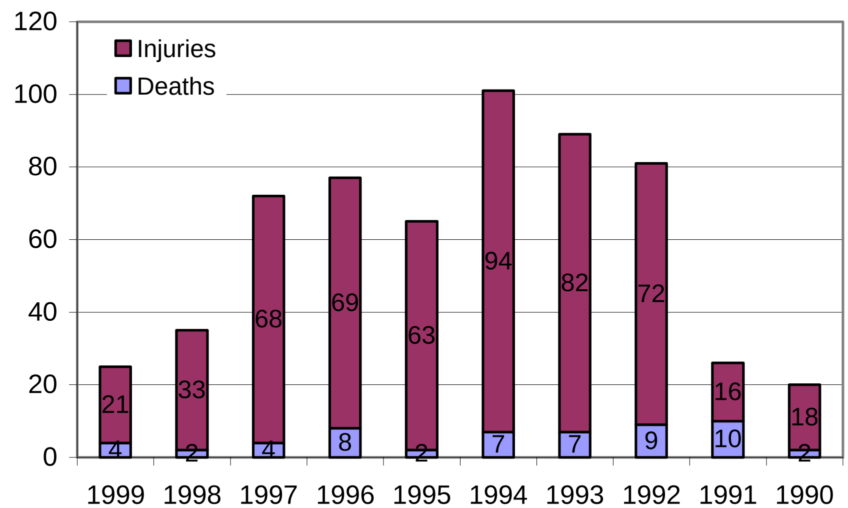
	Ratio Manual/Mechanical
Personnel cost	2.1
Capital cost	0.8
Maintenance cost	0.6
Total Manual/Mechanical	1.5

By assuming that manual clearance is generally 1.5 times more expensive than mechanical clearance for all NGOs, costs can be distributed between these two clearance techniques.

11.4 Cost of Mine Accidents to De-miners

Mine action also takes its toll in the form of accidents during clearance operations. The number of de-miners killed and injured in service for MAPA has decreased during the last two years compared to the mid-1990s. As Figure 11.1 shows, four de-miners were killed during operations in 1999 and 21 injured.

Figure 11.1: Accidents during Mine Clearance, Injuries and Deaths (1990-1999)



De-mining accidents represent a loss to the victims and to society, which can be evaluated in socio-economic terms by applying the same methods as for mine accidents in general, described in Section 5 of this report. A de-miner presumably belongs to the age group 18-40 years, he experiences no unemployment, and in case of accident his medical costs will be fully covered (averaging US$ 4,000). Injuries to de-miners are assumed to be distributed over categories of casualties in the same way as for mine accident victims.

Based on these assumptions, the socio-economic loss for a typical injury to a de-miner is estimated at about US$ 12,500 and that of a fatal casuality at US$ 16,000 (Table 11.8). MAPA accident rates for 1999 – 4 deaths and 21 injuries to de-miners – will be applied as described below, and the cost of these accidents will be added to the de-mining costs.

Table 11.8: Economic Loss From De-mining Accidents, US$.

	Cost per incident US$	Incidents 1999	Loss in US$ per Team Hour
Loss with injuries	12 552	21	3.6
Loss with fatal casualties	16 210	4	0.9
Total loss			4.5

The risk of accidents for de-miners is highest in the case of manual clearance. It is consequently assumed that accident costs will vary with the input of manual team-hours. For 1999 they are estimated to constitute an additional cost of US$ 4.5 per team hour for the manual clearance technique.

11.5 Total Unit Costs of Mine Clearance

Costs per team hour can now be combined with data on team hours needed to clear different types of mined areas from Table 11.4 to derive the unit costs for clearing different types of land using different de-mining techniques. The results are shown in Table 11.9.

Table 11.9: Clearance Costs in US$ per m^2 or US$ Million per km^2 on Land Types

Land type:	Manual	Dogs	Mechanical	Community
Agricultural land	1.3	0.2	2.0	
Grazing area	0.7	0.3	4.4	0.3
Residential areas	3.4	0.3	5.7	
Roads	1.6	0.3	2.6	
Irrigation system	1.0	0.3	1.7	
All mined areas	1.2	0.3	3.4	
Former battlefields	0.04			

Clearance using mine-detection dogs is by a large margin the most cost-efficient method for all types of areas, and hence this technique should be used wherever feasible. Mechanical clearance is the most expensive and is generally called for only when other techniques are too dangerous, in particular for collapsed buildings. Manual clearance is reasonably cost-efficient on grazing areas, and it is in practice the only technique used for former battlefields.

Mine clearance by dog teams is keeping MAPA's costs down. Use of dogs is cost effective and also efficient in clearance time per km^2. A large proportion of MAPA's tasks are now cleared by dogs, and without this method a much higher level of costs would have been experienced. Dogs cannot be used in all conditions and for all types of areas. However, currently the constraint is not the amount of clearance tasks or types of land suitable for dogs; it is rather the number of dogs and the training capacity of MDC.

Since the community-based approach remains a pilot project, it is difficult to draw too many conclusions. Still, costs with this method appear to be remarkably low.

Relatively large cost variations have been found between some of the clearance agencies. There is thus a need to look further into the strengths, limitations, and cost structures of the different techniques and the approach and operational routines of the individual NGOs involved. AREA's community-based approach would be of special interest, but also HALO's achievements should be monitored more closely and compared to the more standard MAPA set up, represented by ATC, DAFA, and OMAR. DDC should also be included in the analysis, once it becomes fully operational. HALO's seemingly low-cost approach did not influence the calculations, since no split between manual and mechanical operations was possible for HALO.

Of the 13 NGOs participating in the MAPA program in 1999, only four ─ ATC, DAFA, OMAR, and HALO ─ were engaged in similar types of activities in mine clearance. Of these, OMAR was totally and HALO partially financed directly from donors. In addition, HALO was loosely integrated in the MAPA program.

Based on these observations, it seems that the mine action NGOs may have managed to reserve secluded areas of activity for themselves. The apparent significant cost differences across some of the de-mining NGOs suggests that there is scope for improving cost-effectiveness. More direct competition between clearance agencies would improve the cost-efficiency of the mine action program. In order to achieve this, the currently rather restricted access to the MAPA program would need to be opened up, with tasks which are now to a large extent assigned on a command basis being put out on some kind of competitive tender to technically qualified agencies. Introduction of competition, however, will take time and needs to be carefully phased.

12. Evaluation of Mine Clearance in Cost-Benefit Terms

It is now possible to pull together all of the calculations of socio-economic benefits and costs made earlier in this paper and conduct a socio-economic cost-benefit analysis of de-mining.

12.1 Methodology

Although substantial resources that have been devoted to mine action in Afghanistan by the assistance community (a total of some $150 million during 1991-1999), a careful evaluation of the socio-economic benefits and costs of this program was not conducted prior to this study. This reflects in part past conceptual approaches to mine action: (1) the "military" approach (i.e. clearing bottlenecks to movements of people and vehicles – echoed in the more recent emphasis on removing "blockages" to communities) and (2) the humanitarian approach (saving lives). But mine action is also (3) a development activity, since it allows those saved from becoming victims of mine accidents to live out economically productive and personally rewarding lives and also brings mine-contaminated land back into productive use. Moreover, whether it is considered a humanitarian or development activity, the mine action program must in any case compete with other worthy humanitarian and development-oriented programs for limited resources available from the assistance community. This study takes a comprehensive approach to the evaluation of de-mining, encompassing the "military", humanitarian, and development perspectives. In this light, the cost-benefit analysis of mine clearance activities in Afghanistan aims to include all relevant benefit and cost components to the extent that available information permits them to be quantified and evaluated in comparable terms.

Conceptually, the socio-economic costs of landmines can be divided into three broad categories: (1) loss of life, health, human production potential, and human welfare resulting from mine accidents; (2) denial of access to mine-infested land and loss of associated production or consumption benefits from the land concerned; and (3) distortion of behavior due to the existence of mines with consequent socio-economic losses resulting from longer travel distances, journeys not undertaken due to greater distance and difficulty, and other distortions in behavior.

In line with the above categorization of the costs of landmines, the specific socio-economic benefits of mine clearance that this study focuses on are (1) the gains in economic productivity due to reduced human losses from mine accidents; (2) the corresponding savings in medical costs; (3) the improvement in human welfare attributable to reduced human losses from mine accidents; (4) the net economic benefits attributable to returning reclaimed land to productive use; and (5) reduced losses of livestock from mine accidents (on those types of land used by livestock).

The following components evaluated in Sections 5-11 form the building blocks for the cost-benefit analysis:

- Reductions in human losses due to mine accidents (Tables 5.7 and 5.8 in particular).
- Productive output from cleared agricultural land (Table 6.13).
- Productive output from areas that have benefited from clearance of irrigation systems (Table 7.3).
- Benefits from cleared grazing areas (Table 8.6).
- Reductions in livestock lost in mine accidents (Table 8.9).
- Reduced transport costs and travel time resulting from renewed access to de-mined roads (Table 9.5).
- Benefits from mine clearance in residential areas (Table 10.2).
- Regional variations in benefit components have been captured in the Case Studies I-XII.
- Full cost of mine clearance per m^2 on various types of land and with techniques currently in use (Table 11.9).

The main evaluation criterion applied in this study will be the Benefit-Cost Ratio (BCR).

$$\textbf{Benefit-Cost Ratio: } \frac{\textbf{Benefit} - \textbf{Cost}}{\textbf{Cost}}$$

Benefits minus costs or net benefits will be the relevant socio-economic criteria. Dividing by costs is done to derive the BCR and facilitates comparison of projects or clearance tasks of different sizes.

The higher the BCR the more well-justified is the project. A negative ratio indicates that this clearance activity cannot be justified on the basis of the socio-economic benefits incorporated in the analysis alone. 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.

The break-even point is when the Benefit-Cost Ratio 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 on the general level of interest rates in a country net of the inflation rate, as well as on other factors.

A high discount rate 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 a low discount rate. Capital is scarce, and competition for funds should be high among a large number of competing uses.

There is evidence of prevailing high rates of interest in Afghanistan. Farmers have to accept significantly lower prices for their crops if they wish to receive payment 5-6 months in advance. Farm gate prices during the harvest season may be as much as 40-50% higher than what farmers actually get during the planting season. Such deals imply a substantial rate of interest, even when the prevailing inflation is taken into account.

An alternative evaluation criterion used in this study to assess the overall socio-economic returns to MAPA's mine clearance operations will be 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 costs. The IRR can be compared for example to the prevailing rate of interest net of inflation in a country. In this study a discount rate of 10% is being used, and the minimum or break-even IRR should consequently be on the order of 10%. This will normally correspond to a BCR of zero as defined above.

The time-horizon for benefits and costs in this study is set at 15 years. After that time benefits are considered too uncertain to be reckoned with. Benefits are discounted over 15 years, while all clearance costs are assumed to be incurred in the first year.

Clearance of mined areas is considered indispensable for increasing food production in Afghanistan and for the repatriation of refugees to the country. MAPA is giving first priority only to areas that will be reclaimed for use immediately (see Section 4). It has therefore been assumed in general that all cleared areas are put into use and that benefits start to accrue immediately after clearance. It was found (see Section 10), however, that some residential areas for various reasons have been only partially or not at all reclaimed for use a long time after being cleared of mines. Few other factors can cause the BCR or IRR to decline as much as not fully realizing benefits in the initial years after costs have been incurred. A first item on the agenda for socio-economic assessment of a particular clearance task should therefore be to ascertain to what extent the area will be reclaimed for use immediately.

The Case Studies introduced previously can now be developed into cost-benefit analyses for a number of model clearance tasks considered typical for MAPA. More specifically, for agriculture-related land use (agriculture, irrigation, and grazing of livestock) the cost-benefit analysis is conducted for eight region-based case studies. There are two case studies each for roads and residential land. In all of the case studies, the analysis is conducted for three different types of de-mining technique (manual, mine-detection dogs, and mechanical). BCRs provide the basis for ranking of the individual tasks.

12.2 Cost-Benefit Analysis of the Case Studies

The main results of the cost-benefit analysis of clearance tasks on different types of mined land using different types of de-mining techniques are shown in Table 12.1. Clearance of irrigation systems provides very large returns generally and in particular for the provinces in Case Studies III, IV, and V, in the Eastern and Southwestern parts of Afghanistan. Irrigation systems in these provinces constitute the clearance tasks that most convincingly can defend use of all kinds of techniques, including mechanical techniques when that is the only feasible option. The provinces belonging under Case Study V in particular, but also III and IV, provide very convincing returns for clearance of agricultural land when dogs can be used. Clearance of roads yields solid returns, for rural areas (Case Study X) not much less than for urban areas (Case Study IX).

Use of mine detection dogs is overall the most cost-effective technique, with the highest BCRs. No other technique provides a higher return for any case study; dogs should consequently be used wherever this technique is applicable.

Mechanical clearance is costly for MAPA. There is scope, however, for applying this technique when needed for irrigation systems in selected provinces, for agricultural land in Case Study V areas mainly, and marginally for roads. Mechanical techniques are currently applied for clearance of residential areas. Justification for this will have to be demonstrated on a case-by-case basis, taking into account the value of the property and in particular the risk that the property may remain unutilized after clearance. Limited data on benefits makes it difficult to draw more definite conclusions with respect to residential property at this stage.

Clearance tasks for grazing areas face difficulties in justifying their costs. Negative net socio-economic benefits may regularly be experienced when techniques other than clearance using mine-detection dogs are applied. All regions show uniform low returns for clearance of grazing land. However, clearance of grazing land is fully justified with use of mine dog teams.

In terms of regions, the Northern Region (Case Study I), which to a large extent represents low-productivity un-irrigated agriculture, provides the weakest justification for clearance tasks on all types of lands. But clearance with use of dogs is nevertheless fully justified.

Table 12.1: Benefit-Cost Ratios for Case Studies of Clearance Tasks

Region		Agriculture			Grazing			Irrigation		
		Manual	Dogs	Mech.	Manual	Dogs	Mech.	Manual	Dogs	Mech.
Case Study I	Northern Region all provinces	-0.5	1.9	-0.6	-0.5	0.2	-0.9	0.1	3.3	-0.3
Case Study II	Parwan, Kabul, Kapisa, Bamyan	-0.1	4.0	-0.4	-0.5	0.2	-0.9	1.7	8.9	0.6
Case Study III	Logar, Wardak	0.4	6.6	0.0	-0.5	0.2	-0.9	3.5	15.9	1.7
Case Study IV	Nangarhar, Laghman, Kunar	0.2	5.6	-0.2	-0.5	0.2	-0.9	2.8	13.3	1.3
Case Study V	Kandahar, Zabul, Oruzgan	1.4	11.6	0.6	-0.5	0.2	-0.9	7.2	29.5	3.9
Case Study VI	Ghazni, Paktika, Paktia	-0.3	2.9	-0.5	-0.5	0.2	-0.9	0.9	6.1	0.1
Case Study VII	Helmand	-0.2	3.4	-0.4	-0.5	0.2	-0.9	1.2	7.4	0.3
Case Study VIII	Herat, Badghis, Farah, Nimroz	-0.2	3.3	-0.5	-0.5	0.2	-0.9	1.2	7.1	0.3

	Roads	Manual	Dogs	Mech.
Case Study IX	Kandahar, Laghman, Kabul	1.0	9.2	0.2
Case Study X	Other provinces except Case IX	0.8	8.5	0.1
	Residential			
Case Study XI	Kabul, Kandahar	0.8	17.2	0.0
Case Study XII	Other provinces except Case XI	-0.1	8.0	-0.5

The individual clearance tasks forming the background for Table 12.1 are listed in Annex 3. The relative weights of the different benefit and cost components appear there, and the tasks are listed in descending order of BCR. For cases with high BCRs, it is the productive output from land that makes the difference. The human loss fluctuates less across the different Case Studies. However, clearance tasks on grazing areas may be justified in many cases on account of avoided human loss alone.

It was intended that the selected Case Studies should as much as possible be representative, so that conclusions on benefits and costs can be applied to a wide range of similar tasks. The Case Studies conducted as part of this study, and the results from Table 12.1 in particular, should thus be able to provide guidance for particular clearance tasks at different locations and for future years. However, the actual socio-economic returns of any particular mine clearance activity will depend in large part on the characteristics and quality of the specific land being cleared, the density and types of mines, the cost-efficiency of the de-mining agency, and other factors affecting the difficulty of mine clearance.

12.3 Cost-Benefit Evaluation of the MAPA Program as a Whole

The data analysis carried out also permits a socio-economic cost-benefit evaluation of the entire MAPA program. Calculations have been carried out for 1999, and the results are shown in Table 12.2.

Table 12.2: Net Benefits of the MAPA Mine Clearance Program 1999, US$ Millions

	Agriculture	Grazing	Irrigation	Residential	Roads	Total
Manual	3.4	-2.6	3.7	2.0	0.0	6.5
Dogs	14.4	0.1	1.6	3.1	5.6	24.9
Mechanical	0.0	0.0	0.0	-0.1	0.0	-0.1
Total	17.7	-2.5	5.3	5.1	5.7	31.3

The net benefits of the MAPA mine clearance program for 1999 amount to over US$ 31 million, resulting in a high BCR of 1.2. The largest portion of socio-economic benefits results from clearing agricultural land using mine-detection dogs. Clearing agricultural land and irrigation systems with manual methods and roads with dogs also make significant contributions to total net benefits.

Use of manual techniques for clearance of grazing areas is more expensive than the estimated socio-economic benefits can justify. Clearance of residential areas using mechanical techniques also contributes negatively to the total net socio-economic benefits of MAPA.

The internal rate of return (IRR) of the total MAPA mine clearance program for 1999 is estimated at 28%, which provides a very strong justification for the program. Clearing of irrigation systems, roads, residential areas, and agricultural land with dogs, as well as irrigation systems with manual techniques, show particularly large economic returns. Clearance of grazing areas earns marginal returns, and positive IRRs for this type of land in general are found only when dogs can be used.

The total costs of the MAPA program for 1999, not including mine-awareness activities, are estimated at about US$ 28 million, somewhat higher than the US$ 22 million figure in the Annual Report for 1999, which covers the AETF funded part of the program only. On this basis, MAPA's clearance costs for mined areas for 1999 are US$ 0.77 per m^2.

The unit cost of battlefield clearance is estimated at US$ 0.04 per m^2, with a total cost for 1999 of US$ 2.6 million.

The reasons for the cost adjustments in the total cost figure are set forth in Section 11. The fact that AETF funding only covers 85% of the mine clearance and 54% of battlefield clearance costs accounts for much of the increase in costs (US$ 5 million). The socio-economic costs of mine accidents to de-miners also have been added. On the other hand, the estimated costs of mine clearance have been adjusted downwards by removing mine awareness costs from the AETF budget.

Another factor contributing to the higher cost estimate is that the costs applied for manual and mechanical techniques are based on data from ATC. In general, these deviate somewhat from DAFA and OMAR on the low side but are substantially higher than HALO's costs, as can be seen in Table 11.6. In Wardak province at least, HALO is operating with much lower costs those that are being used in the analysis of this study.

Finally, the unit costs calculated here all include the UNOCHA overhead of 13%. Clearance tasks financed directly by donors avoid this cost, however. This was the case for 15% of the minefields cleared of mines and 46% of the former battlefield areas cleared of UXO in 1999.

There is a need to look further into the cost structures of the different mine clearance NGOs to explain such variations. The cost model used in this study may need to be corrected on the basis of new findings. Given the conservative assumptions on which the current cost estimates are based, corrections and refinements are likely to reduce the cost figures.

Based on the unit cost data calculated in this study, it is possible to roughly estimate the cost of clearing the remaining identified and surveyed minefields in Afghanistan. The average estimated unit cost of $0.77 per sq. m. should be reduced somewhat, however, to take into account efficiency improvements that would result from scaling up and further increasing the use of mine-detection dogs. Hence a figure of $0.60 (20% lower) is used for the purpose of these illustrative calculations. On this basis, it is roughly estimated that clearing the remaining minefields identified by MAPA as high-priority would cost about $200 million, and that clearing other minefields would cost another $250-300 million, depending on how many more previously undiscovered minefields are found. In a situation where there is an end to conflict and large numbers of refugees and displaced persons return to their homes, land use and movements of people will increase (with associated higher risks of mine accidents), so it will make sense to expand the de-mining program and make faster progress toward eliminating the problem of landmines for the bulk of the Afghan people.

12.4 Sensitivity Analysis

An alternative scenario, under which the welfare loss is excluded from the calculation of the human loss from mine accidents, has been introduced in Section 5 (see Table 5.8). This results in a decrease in benefits from reduced human loss in proportion to the accident risk for different types of mined areas. The value of human loss associated with de-mining accidents will be likewise reduced.

Table 12.3: Benefit-Cost Ratios for Case Studies of Clearance Tasks under Alternative Assumption

Region		Agriculture			Grazing			Irrigation		
		Manual	Dogs	Mech.	Manual	Dogs	Mech.	Manual	Dogs	Mech.
Case Study I	Northern Region all provinces	-0.7	0.5	-0.8	-0.8	-0.4	-1.0	-0.4	1.3	-0.6
Case Study II	Parwan, Kabul, Kapisa, Bamyan	-0.3	2.5	-0.6	-0.8	-0.5	-1.0	1.1	7.0	0.3
Case Study III	Logar, Wardak	0.1	5.1	-0.2	-0.8	-0.5	-1.0	3.0	14.0	1.4
Case Study IV	Nangarhar, Laghman, Kunar	0.0	4.1	-0.4	-0.8	-0.5	-1.0	2.3	11.3	1.0
Case Study V	Kandahar, Zabul, Oruzgan	1.1	10.2	0.4	-0.8	-0.5	-1.0	6.6	27.5	3.6
Case Study VI	Ghazni, Paktika, Paktia	-0.5	1.5	-0.7	-0.8	-0.5	-1.0	0.4	4.1	-0.2
Case Study VII	Helmand	-0.4	1.9	-0.6	-0.8	-0.5	-1.0	0.7	5.4	0.0
Case Study VIII	Herat, Badghis, Farah, Nimroz	-0.5	1.9	-0.6	-0.8	-0.5	-1.0	0.7	5.2	0.0
Roads		Manual	Dogs	Mech.						
Case Study IX	Kandahar, Laghman, Kabul	0.6	7.4	0.0						
Case Study X	Other provinces except Case IX	0.5	6.7	-0.1						
	Residential									
Case Study XI	Kabul, Kandahar	0.6	15.5	-0.1						
Case Study XII	Other provinces except Case XI	-0.3	6.3	-0.6						

The main conclusions from Table 12.1 remain valid under this alternative scenario. For the majority of the clearance tasks, the change has a somewhat marginal impact. Socioeconomic returns remain high for clearance by dogs on agricultural land, irrigation systems, and roads (see Table 12.3). Manual clearance becomes a somewhat less beneficial option for irrigation systems, roads, and for a some of the agricultural case study areas. The most conspicuous change is that the BCR for clearance of grazing areas becomes negative for all techniques and in every case study region.

The alternative assumption would reduce net benefits from clearance under the MAPA program in 1999 to US$ 20 million, and the overall benefit-cost ratio would decrease to 0.8. Benefits from clearance of grazing areas generally fail to cover costs, while clearance of other types of areas still contributes positively where dogs or manual methods are used.

Table 12.4: Net Benefits of MAPA Clearance Program 1999 under Alternative Assumptions, US$ Millions

	Agriculture	Grazing	Irrigation	Residential	Roads	Total
Manual	0.8	-4.0	3.4	1.0	0.0	1.2
Dogs	10.5	-0.3	1.3	2.5	4.5	18.5
Mechanical	0.0	-0.1	0.0	-0.1	0.0	-0.2
Total	11.3	-4.4	4.7	3.5	4.5	19.6

The alternative assumptions in the sensitivity analysis reduce the IRR of the MAPA program from 28% to 21%, which is still a convincing rate of return. In general, the IRR declines by a percentage related to the role reduced human loss plays among the benefits from the clearance tasks.

A second sensitivity check also was discussed in Section 5. In addition to excluding human welfare loss from the analysis, the estimated incidence of mine accidents (per km^2) could be reduced by half. These two important changes in assumptions together almost certainly result in substantial underestimation of the human loss attributable to mine accidents. However, this second alternative scenario is nevertheless useful for the purpose of coming up with a rock-bottom estimate of the socio-economic benefits and returns of mine clearance in Afghanistan.

As can be seen from Table 12.5, the estimated net socio-economic benefits of the MAPA mine clearance program fall to US$ 16 million under this scenario, for a BCR of 0.6. The IRR also falls to 19%. These estimated returns are still quite respectable and significantly above the cut-off points normally used in decisionmaking on public investment projects and other public sector programs.

Table: 12.5 Net Benefits of MAPA Clearance Program 1999 under Alternative Assumption with Reduced Mine Accident Rate, US$ Millions

	Agriculture	Grazing	Irrigation	Residential	Roads	Total
Manual	-0.1	-4.5	3.3	0.7	0.0	-0.5
Dogs	9.3	-0.5	1.2	2.3	4.1	16.4
Mechanical	0.0	-0.1	0.0	-0.1	0.0	-0.2
Total	9.1	-5.0	4.5	2.9	4.1	15.7

13. Economic Evaluation of Other Mine Action Program Activities

13.1 Introduction

In addition to survey and clearance of mined areas, MAPA's of activities include, among others (see Section 4):

- Survey and clearance of former battlefields.
- Mine and UXO awareness and education.

Data are available on the cost side of these components. The cost of UXO clearance is discussed in Section 9 of this report. Benefits of these components have not yet been systematically evaluated, however. Further data collection and analysis will be needed on the benefits from battlefield clearance, in particular on the frequency of UXO accidents, and on the impact of mine awareness campaigns on rates of accidents of different types.

Survey and marking of minefields and former battlefields are integral parts of clearance; all areas will normally be surveyed and marked as preparation for clearance. It is possible, however, that surveying and marking, or sealing off mined areas with fences, could constitute an alternative to clearance in some cases, in combination with targeted mine awareness campaigns. The socio-economic benefits and returns attributable to such activities need to be assessed.

13.2 Clearance of Former Battlefields

Former battlefields, at which major clashes and combat occurred at different stages of the war, normally contain numerous items of unexploded ordnance (UXO), as well as vast amounts of fragments of different varieties of ammunition, weapons, and other equipment.

MAPA started clearance of former battlefields in 1994. As of the end of 1999, more battlefield areas (240 km^2) have been cleared on a cumulative basis than minefields (about 200 km^2).

The main areas for battlefield clearance have been the central and eastern parts of the country, especially Kabul which has been the top province every year since 1995 (see Table 13.1). Nangarhar (with Jalalabad) had large areas cleared in 1994. Wardak, situated in the same part of the country, comes third. In addition, there has been UXO clearance activity in the North, in the provinces of Baghlan and Kunduz, as well as in the West on the border with Iran (in Herat and Farah). Activity seems to be picking up, with 11 provinces included in the UXO clearance program in 2000.

Table 13.1: Clearance of Former Battlefields in km^2

Province	Total	2000-July 31	1999	1998	1997	1996	1995	1994
Kabul	188.6	19.8	51.6	35.9	36.8	33.4	10.9	
Nangarhar	33.5	1.8			2.8		6.2	22.7
Wardak	25.7	8.1	16.4	1.2				
Baghlan	7.3	2.0	3.4	0.6	1.3			
Kunduz	6.1	2.1	3.3	0.7				
Herat	5.7	0.6			5.1			
Farah	4.6	2.9			1.8			
Helmand	2.7		0.1	0.2	0.0	0.7	1.8	
Samangan	2.0	2.0						
Logar	1.9	0.1	0.6	0.4	0.8			
Kandahar	0.8		0.2				0.6	
Parwan	0.6				0.6			
Paktika	0.6	0.6						
Nimroz	0.4	0.4						
Badghis	0.2			0.2	0.0			
Faryab	0.1				0.1			
Total	280.9	40.4	75.7	39.1	49.2	34.1	19.5	227

Former battlefields have not yet been included in socio-economic analysis of the benefits from the mine action program. SEIS did not attempt to calculate the benefits from clearance of these areas, and no socio-economic data are being gathered about former battlefields in the current surveys for the MIS database. Moreover, these areas are not classified in terms of type of potential use.

Former battlefields by definition do not contain mines (otherwise they would be classified as minefields), whereas UXO and fragments may be found in large numbers. These usually will not explode unless tampered with or forcibly removed. Former battlefields are therefore not blocked from all use by UXO to the same extent as active mines can block use of an area.

UXO are mainly a threat to people who pick them up to experiment with them or to collect them for sale as scrap metal. It is sometimes argued that many of the mine victims reported in Afghanistan are in reality UXO victims, but deficient data make estimation of the percentage of UXO victims very difficult.

The cost of clearance is much lower for former battlefields than for minefields. The amount of team-hours it takes to clear a given battlefield area is about 1/30 of what it takes to clear a minefield of equal size. The estimates presented in Section 11 indicate a cost of 3.5 US cents per m^2, or 35,000 US$ per km^2. Almost all former battlefields are currently cleared using manual techniques. The total cost of MAPA's clearance of UXO from former battlefields in 1999 is estimated at US$ 2.6 million.

On the basis of these costs and the benefit calculations presented in the previous section, some rough estimates can be derived on the minimum level of socio-economic benefits sufficient to justify clearance of UXO from one km^2 of former battlefield area.

Benefits in excess of this would imply a positive BCR. These estimates are presented in Table 13.2.

Table 13.2: Clearance Cost of Former Battlefields as Compared with Possible Benefit Components.

	1000 US$
Cost of battlefield clearance per km^2.	35
Economic loss at one fatal casualty	12
Economic loss of an average mine victim	9
One victim each year over 15 years	69
10% of benefits for agriculture Case Study VI	36

The socio-economic loss associated with a risk of three fatal casualties in the immediate future would correspond to the clearance costs of one km^2 former battlefield, the loss of four average mine/UXO victims likewise. An accident risk of one victim each year over 15 years constitutes a loss of US$ 69,000, which is well above the clearance cost of US$ 35,000 per km^2 and would result in a high BCR.

Losses can also be considerable in cases where UXOs create problems for land use. Net revenue from one year's cultivation of a km^2 of agricultural land, for example, exceeds US$ 36,000 in all Case Studies except Case Study I (Table 6.13).

Further analysis will be needed to draw meaningful conclusions on the benefits from UXO clearance activities. Assertions have recently been made that a larger share of the number of victims could be related to UXO accidents rather than mines. This claim needs to be carefully looked into, hopefully with more precise data on victims that can clearly differentiate victims of mines and victims of UXO. In case it turns out that a large proportion of victims should be reclassified as UXO victims, this could lead to recommendation that MAPA's clearance activities be directed away from costly mine clearance to the much less expensive clearance of former battlefields.

13.3 The Role of Mine Awareness

Mine awareness is an integral and important part of all UN mine action programs worldwide, including MAPA. It can be highly effective in reducing the risk of accidents from active minefields and UXO and thereby would lower the numbers of victims. Mine awareness is regularly considered as an integral part of mine clearance. The goal of mine awareness is to train and inform civilians so that they can live and work safely in the vicinity of active minefields. This is especially relevant for Afghanistan, since most likely a considerable risk of encountering mine incidents will remain long after the identified high-priority mine-infested areas have been cleared.

A conclusion from the SEIS study and other observations is that a remarkably small percentage of mine victims report that they have received mine awareness training, whereas reportedly more than six million Afghans have attended mine awareness courses under MAPA, 1.5 million in 1999 alone. It appears, however, that many people may have attended more than one mine awareness course.

It has also been argued that victims might be reluctant to admit to having ventured into marked minefields or having tampered with UXO after receiving mine awareness training. Nevertheless, there is good justification to look into what it would require in the way of extra resources and skills to make mine awareness initiatives better targeted and more effective.

A comprehensive analysis will be needed to assess the effects of mine awareness activities in terms of reduced frequency of mine and UXO accidents. Mine awareness would certainly be assigned a crucial role if surveying, marking, and sealing off mined areas is adopted as a self-contained mine action strategy and an alternative to clearance where the latter would be too difficult and costly.

The mine awareness component constitutes about 7% of total MAPA program costs, or US$ 1.8 million of the US$ 26.3 million identified as funding requirements for 2000. The cost-effectiveness of mine awareness as an *alternative* to clearance will depend in large part on the amount and the time horizon for necessary future inputs of mine awareness activities connected to such a strategy.

14. Local Community Involvement

14.1 The Scope for Mobilization of Local Communities

The analysis conducted in this study aims to provide a basis for dealing with the mine problem in Afghanistan from an integrated socio-economic perspective. Mine action takes place in a local community context, however, and it is important to provide opportunities for the local people to express their wishes and priorities on mine action in the context of development programs in general. Local community involvement should be initiated at an early stage of the mine action planning process.

Local people are in a position to provide valuable information needed for conducting mine action operations, and in particular data on socio-economic issues. The aim of the present study is to provide basic data and methods for analysis. This information can always be improved by access to more site-specific information. Hence consultations with the local community should form an important part of all fact-finding efforts.

Meaningful local participation rather than a top-down approach also will reduce the potential for conflicts and contribute to greater the ownership of the mine action program on the part of the local community. Local people should be given the opportunity to bring their influence to bear by providing information and their viewpoint. Participation from otherwise marginalized groups, such as women, land-less people, etc., may need to be particularly encouraged.

14.2 Priorities on Areas to be Cleared

It is important to involve local communities in setting priorities on which areas should be cleared first. This will enable the mine action program to productively make use of local knowledge about the mined areas under consideration. It will also promote community ownership and participation in activities as appropriate. Of particular importance are the views of communities about which mined areas will be put back into productive use immediately or very soon after mine clearance, since this is a critical determinant of the socio-economic benefits and returns.

The local community may have viewpoints on various aspects of the program, and also on technical questions like the clearance technique to be used, in particular since mine action is a major employer in Afghanistan. People's opinions for example on community-based mine clearance could be important. Resource persons with special qualifications might be identified locally, so that they can be assigned roles in the program.

Cooperation with the local community is of course important in other aspects of mine clearance as well, in the interest of smooth operations and avoiding conflicts, thefts of equipment, and damage to installations. A feeling of local ownership of the program is often a guarantee for good cooperation, and this attitude can be created and sustained through active involvement by the local people right from the beginning.

14.3 Priorities on Mine Clearance Versus Assistance for Other Purposes

It would be desirable if the local community could also express its views on priority-setting among the main sectors of development and support, such as health, education, water supply, and other similar activities. Ideally, it should be possible to divert funds from mine-action to other sectors and vice-versa, when the local community expresses well-conceived priorities in this regard.

At present this will not be possible to any significant extent, as most funds are firmly tied to specific programs. Within the existing context, rational behaviour on the part of the local community will be to seek every opportunity for external funding that emerges, and leave the responsibility for overall planning to others.

15. Conclusions and Recommendations

This study has focused on the socio-economic benefits resulting from reductions in mine accidents in terms of productivity and welfare and the economic benefits from making cleared land available for productive use. The study has found that the socio-economic returns to de-mining are high in general, fully justifying the allocation of substantial resources by the international assistance community for this activity. These high returns are particularly striking since not all benefits could be quantified and included in the calculations, and moreover, conservative assumptions have been used in estimating the benefits of de-mining in terms of reduced human losses.

The socio-economic loss related to a fatal casualty from a mine accident in Afghanistan is conservatively estimated at less than US$ 12,000. The loss from a typical mine victim is estimated at about US$ 9,000, when the proportion of different types of casualties have been taken into account along with their respective degrees of disability.

Turning to the productive value of cleared land, the net value of agricultural output exhibits wide variations, from about US$ 14,000 per km^2 land annually to over US$ 300,000 in some cases. The corresponding benefits from mine clearance also vary accordingly.

The net annual output value from livestock rearing on one km^2 of grazing area varies roughly between US$ 1,200 and US$ 2,000. Both the level of benefits and the variation in benefits are much less than those encountered in the agricultural sector.

The benefits from clearance of mined roads are considerable, over US$ 250,000 annually per 50 km (corresponding to one km^2 mined road area). Benefits are high both for clearance of urban roads and in the case of rural roads.

The highest returns as estimated in the case studies are for clearance of irrigation systems in provinces with good conditions for agriculture. These clearance tasks can most convincingly justify use of all kinds of de-mining techniques. Socio-economic returns also are high for clearance of highly productive agricultural land and for roads.

One crucial factor is whether the land being cleared will be brought back to productive use shortly after being de-mined. If this does not occur, socio-economic returns are lowered and would turn negative if there is a significant delay.

Mine clearance on grazing land earns relatively low socio-economic returns. Techniques other than dogs or community-based methods would be expected to earn negative economic returns when applied to grazing areas. All regions show uniform small returns for de-mining of grazing land.

The broader, difficult-to-quantify benefits from mine action would make clearance of grazing lands more justifiable than is indicated from the case study findings. Nevertheless, it would be desirable to develop and try out less expensive clearance methods if MAPA is to include substantial amounts of grazing areas in its program, and in particular if areas of lower priority would be considered for extensive de-mining work in the future. Expansion of the community-based approach could be a promising option in this regard.

Clearance using mine detection dog teams is overall the best technique, with the highest BCRs under all conditions where use of dogs is feasible. No other technique generates higher returns for any clearance task. Dogs consequently should be used wherever this technique is applicable. Currently, dog teams are responsible for clearing about half of the area being de-mined, but the binding constraint is not the type of land suitable for dog clearance. With more dogs available, including larger training capacity for dogs, use of this technique could be further expanded. Increased reliance on dogs will have some implications for employment in de-mining, although dog teams also employ substantial numbers of people for mine extraction. Further expansion in the use of dogs for mine detection would allow the mine action program to clear a larger area of minefields with the same quantum of resources.

Mechanical clearance is costly to MAPA in relation to the socio-economic returns. This technique should be applied only when no other options are feasible, and the socio-economic justification will need to be demonstrated on a case-by-case basis.

The net benefits of the MAPA mine clearance program in 1999 are estimated at US$ 31 million, resulting in a high BCR of 1.2. The corresponding internal rate of return is 28%. These results are robust to sensitivity analysis. Excluding the welfare benefits of reduced mine accidents, for example, results in a BCR of 0.8 and an IRR of 21%. If in addition, as a second sensitivity check, the estimated number of mine accident victims per unit of mined land area is reduced by half, the BCR further declines to 0.6 and the IRR to 19%, still quite respectable and significantly above normal cut-off rates for decisions on public investment projects or other programs. The largest portion of net socio-economic benefits is attributable to clearance of agricultural land with dogs. Clearance of agricultural land and irrigation systems with manual methods as well as clearance of roads with dogs also make strong contributions to MAPA's overall socio-economic benefits.

MAPA's clearance costs for mined areas are estimated to US$ 0.77 per m^2 in 1999, while clearance of UXO from former battlefields costs an estimated US$ 0.04 per m^2. The area of minefields cleared per team hour of work under the MAPA program has decreased over time. Generally it is far more time-consuming to clear minefields than former battlefields. Agricultural land comes close to the average in area cleared per team hour, while grazing areas are normally much less and residential areas far more time consuming to clear.

Based on the analysis conducted in this study and some further assumptions, it is roughly estimated that clearing the remaining minefields identified by MAPA as high-priority would cost about $200 million, and that clearing other minefields would cost another $250-300 million, depending on how many more previously undiscovered minefields are found.

The socio-economic analysis of mine action can be based on the tools developed in this study. There will nevertheless be a need for continuous information collection, for updating of Case Studies and databases, and for specific fact-finding for evaluation of individual clearance tasks. The more generalized assumptions in the study could then be supplemented or replaced by site-specific data.

For analytical purposes, the estimated BCRs in Table 12.1 can constitute a first approach, while data from Annex 3 can be consulted when modifications of assumptions at an aggregate level are required. In case a more tailored analysis is needed, details can be extracted from the tables presented in Sections 5-10 on benefits and in Section 11 on costs. It is also possible, to a certain extent, to make amendments directly in the numerous spreadsheets which comprise the quantitative base on this study.

The local community should be actively involved in the mine action planning process (as discussed in Section 14), with opportunities to express their wishes and priorities for mine action in the context of local development programs in general.

A coordinated initiative to improve mine and UXO victims' statistics in Afghanistan is urgently needed. Questions about landmines in a broader household survey would form a very useful component of such an initiative. The regular collection of statistics on mine and UXO accidents needs to be better coordinated among the agencies involved. Mine and UXO victims' statistics are highly deficient at present. Some observers have suggested that large numbers of victims could be associated with UXO accidents rather than mines. This might imply that MAPA mine clearance activities should be shifted at least at the margin from costly mine clearance to the much less expensive clearance of former battlefields. This issue illustrates the importance of improving the information base on mine/UXO accidents and victims.

Surveying, marking, and fencing off minefields, together with well-targeted mine awareness campaigns, could be developed as an alternative approach to mine clearance, especially for lower-priority areas where the economic returns to de-mining are doubtful. Collapsed buildings – where mechanical de-mining would normally be used, manual de-mining would be dangerous, and dogs unusable – might be a good example.

Relatively large cost variations have been found between some of the mine clearance agencies. There is a need to look further into the strengths, limitations, and cost structures of the different clearance techniques and also the approaches and operational routines of the individual agencies involved. In this connection, more detailed cost data from the mine clearance agencies will be needed. For this and other purposes, it is recommended that all mine clearance agencies introduce standard account systems and administrative routines that make possible presentation of revised accounts on a timely basis.

MAPA is currently financed mainly through UNOCHA, but considerable funds are also passed from donors directly to individual NGOs. The amount of funds passed on directly is still only partially known to MAPA. It is recommended that MAPA start collecting this information on a regular basis.

More direct competition among mine clearance agencies could be a means of improving the cost-efficiency of the mine action program. In order to achieve this, the rather restricted access to the MAPA program will need to be opened up. Tasks now to a large extent assigned on a command basis could be put out for some kind of competitive tender, to encourage competition among technically well-qualified bidders.

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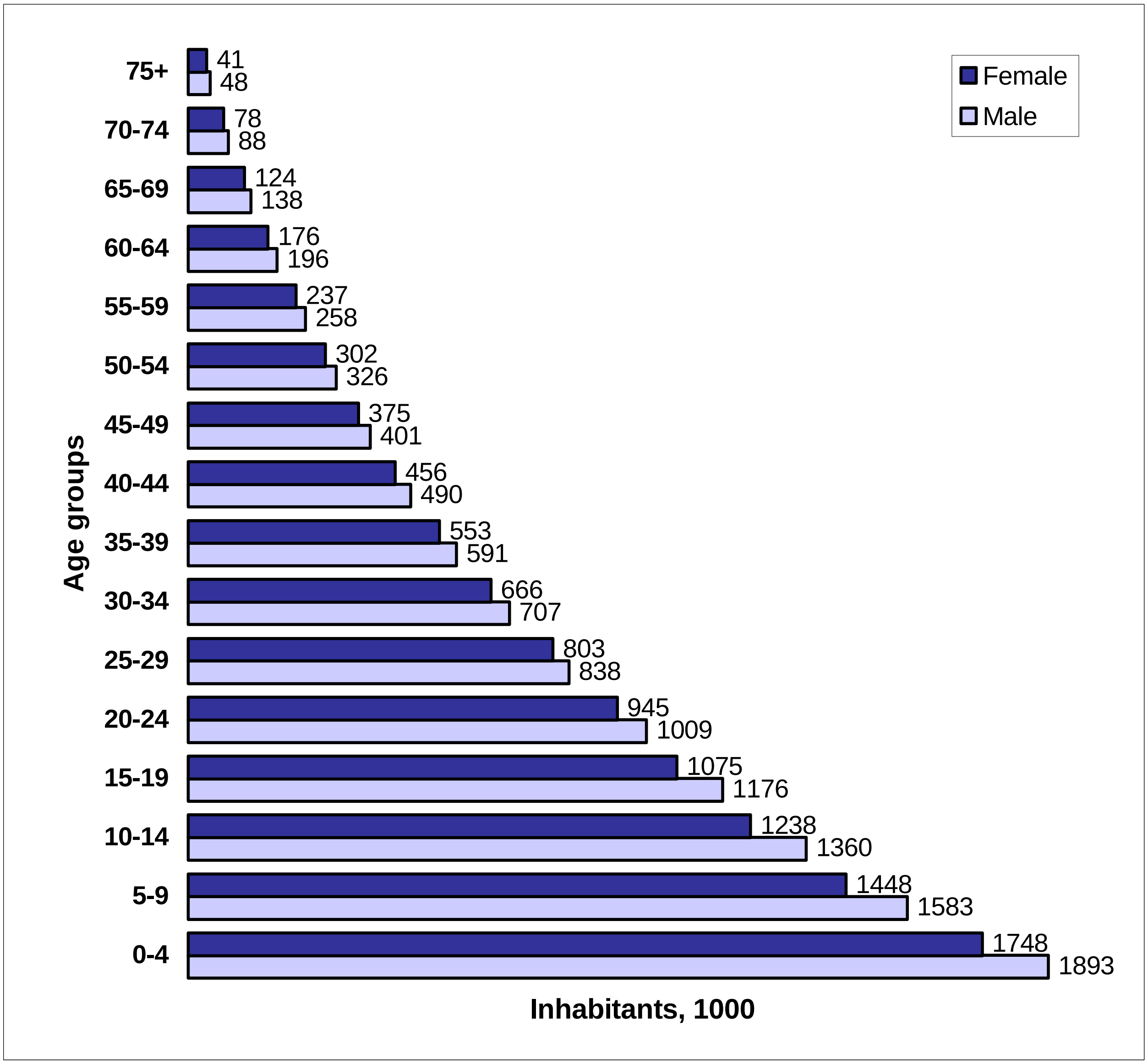
ANNEXES

Annex 1: Population of Afghanistan (1000) by Age Groups



Source: Mohammad Ershad: Population of Afghanistan, IIPS, Bombay 1983

Annex 2: Mine and UXO Clearance Costs – Detailed Explanation

Table 1: Cost Calculations for 1999

	1999	Mine and Former Battlefield Clearance								Survey	
1/		**man-mec**	**man**	**man-mec**	**man-mec**	**dogs**	**man-mec**	**man**	**Total**		
2/	Agency	ATC	AREA	DAFA	OMAR	MDC	HALO*	MCPA	ex MCPA	MCPA	HALO
3/	Minefield km^2	6.63	0.38	2.95	3.48	16.88	1.65	0.28	31.97	31.99	5.01
4/	Battlefield km^2	23.81		0,06			17.24	0.28	41.11	23.79	54.15
5/	Team hours, 1000	32.22	3.48	14.73	9.84	19.84	17.40	1.23	97.51	983.49	204.45
6/	- manual clearance	28.08	3.48	14.73	9.84		15.48	1.23			
7/	- mechanical/dog	4.14				19.84	1.92				
	US$ 1000										
8/	UNOCHA fund	5717.39	167.96	2581.35		3440.28	1375.60		13282.58	1 447.38	
9/	UNOCHA overhead	741.68	21.79	334.86		446.28	178.45		1723.06	187.76	
10/	In kind contribution	0.12	0.00	0.06		0.07	0.03			0.03	
11/	Mine Dog Sets					-904.78				904.78	
12/	Other fund				1965.50				1965.50		
13/	Total cost US$ 1000	6459.19	189.76	2916.26	1965.50	2981.86	1554.08		16066.64	2539.95	
14/	- non expendable equipment	925.00	2.23	74.33		33.00	109.18			40.00	
15/	+ depreciation	185.00	0.45	14.87		6.60	21.84			8.00	
16/	+ earlier years depreciation	185.00	4.01	133.79		59.40	196.52			72.00	
17/	Operations costs US$ 1000	5904.19	191.98	2990.59	1965.50	3014.86	1663.25			2579.95	
18/	Cost US$ per Team Hour	183.25	55.17	203.03	199.75	151.96	95.59		502.57		
19/	Monitoring, Training	5.17	5.17	5.17	5,17	5.17					
		man-mec	**manual**	**man-mec**	**man-mec**	**dogs**	**man-mec**				
	Clearance Cost US$ per Team Hour	ATC	AREA	DAFA	OMAR	MDC	HALO*				
20/	Manual and mechanical teams, dogs	188.42	60.34	208.20	204.92	157.13	95.59				
21/	Manual clearance cost US$ per Team Hour	196									
22/	Mechanical clearance cost US$ per Team Hour	131									

1/ Techniques in use comprise manual, mechanical, and mine-detection dogs.
2/ AREA is engaged in the community-based approach.
3/ Data on minefields cleared using manual techniques.
4/ Former battlefields cleared and surveyed is mainly from the MAPA Annual Report for 1999, but corrections have been made for HALO, comprising only MAPA financed activities in Wardak province.
5/ Information on team-hours is collected from the MAPA Minefield Database. Team hours are corresponding to the areas cleared.
6/ Team hours are distributed on manual clearance.
7/ Team hours are distributed on mechanical/dogs clearance.
8/ Information about UNOCHA funds is taken directly from the Annual Report for 1999, page 27, AETF expenditure by agency.
9/ UNOCHA overhead is added at the assessed rate of 13%.
10/ The MAPA Annual Report for 1999 also gives information about in-kind contributions, which have been distributed over agencies on the basis of work performance in team hours.
11/ The cost of Mine Dog Sets working on survey tasks has been deducted from MDC and added to MCPA survey operations.
12/ With respect to other funds provided directly by donors to agencies, there is information only from OMAR, which is funded entirely outside UNOCHA/AETF for its mine clearance operations.
13/ The total costs of agencies are corrected for the above-mentioned items. Total cost for MCPA in this row will be considered as total survey costs. These costs will be divided by the amount of areas surveyed in km^2 and distributed over agencies on the basis of areas cleared.
14/ The cost item non expendable equipment in the MAPA Annual Report for 1999, page 27 AETF expenditure by agency, comprises investments and should be treated like them. It has therefore been deducted from total costs.
15/ Depreciation on basis of 20% per year (or depreciation over five years) is added, comprising capital equipment procured in 1999 only.
16/ For non expendable equipment procured in earlier years, information is not yet available (this should be looked into). For the calculation of depreciation it has been assumed, however, that ATC was renewing 50% of its capital in 1999 and the other agencies 10%.
17/ Costs are corrected once more on the basis of 14-16.
18/ Costs are calculated per team hour performed by the various agencies. Team hours presumably are the best available denominator for distribution of costs, better than per m^2 cleared, since performance varies greatly in terms of area cleared with both type of area, technique and over time. Team hours are assumed to vary mainly with clearance technique.
19/ META's costs for monitoring, evaluation and training are added on a per team-hour basis.
20/ Clearance costs per team hour are known for the different agencies and techniques. Cost data on clearance by MDC dogs are complete and are used directly in the calculation of costs per km^2 cleared of different types of land in table 11.8 of the report, with survey costs added. Data for AREA's community-based approach also are considered complete. A break-up of costs for the agencies using manual and mechanical techniques will, however, need another approach, which will be explained later in this Annex.
21/ The results these calculations are shown as manual clearance cost in US$ per team hour and and
22/ Mechanical clearance cost US$ per team hour. These calculations have been based on data from ATC only.

The estimated break-up of mine clearance costs as between manual and mechanical de-mining is based on available data from ATC only.

Table 2: Manual Teams

Team Personnel Cost	
US$/year	155520
Team hours worked year	1578
Personnel cost US$/hour	99

Capital costs	Cost US$	Life time years	Capital cost/hour	Maintenance	Maintenance US$/ hour
Mine detectors (13)	32500	2	10	10 %	2,1
Helmet (15)	3750	2	1	10 %	0,2
Vizor (15)	3750	0,5	5	10 %	0,2
Truck 4x6 Kamaz (1)	31500	5	4	10 %	2,0
Ambulance 4x4 Land Cruiser (1)	25000	5	3	10 %	1,6
Pick up Twin Cabin 4x4 Toyota (1)	17000	5	2	10 %	1,1
Apron (12)	9000	5	1	10 %	0,6
Total	122500		27		7,8

Cost US$/Team hour	US$/Team hour
Team Personnel Cost	99
Capital cost	27
Maintenance cost	8
Team cost/Manual Team hour	133

Table 3: Mechanical Teams

Team Personnel Cost	
US$/year	69540
Hours worked	1508
Personnel cost US$/hour	46

Team Equipment Cost	Total cost US$	Life time years	Capital cost/hour	Maintenance	Maintenance US$/hour
Mine detectors (4 partic + 2 spare = 6)	15000	2	5,0	10 %	0,99
Ambulance 4x4 Nissan Patrol (1)	24000	5	3,2	10 %	1,59
Pick up 4x4 Nissan (1)	18500	5	2,5	10 %	1,23
VHF Hand Sets (3)	1800	2	0,6	10 %	0,12
Helmet (6)	1500	2	0,5	10 %	0,10
Visor (6)	1500	0,5	2,0	10 %	0,10
Apron (4)	3000	5	0,4	10 %	0,20
Backhoe Machine	134000	5	17,8	10 %	8,89
Total			31,9		13,22

Cost US$/Team hour	US$/Team hour
Team Personnel Cost	46
Capital cost	32
Maintenance cost	13
Team cost/Mechanical Team hour	91

The ratio between costs for a manual team hour and a mechanical team hour derived from these calculations is about 1.5. The total costs of ATC as given in Table 1 in this Annex will be distributed between the two techniques on this basis. Information on ATC team hours for manual and mechanical techniques is available from the MAPA Minefield Database.

The average cost per team hour from Table 1 (row 20) of US$ 188 will on this basis be split as follows:

Table 4: Manual and Mechanical Teams Costs in US$ per Team Hour

Clearance Cost	Total Cost	Accident Cost	Team Cost	Overhead	Overhead %
Manual Teams	196	4.5	133	58	44
Mechanical Teams	131		91	40	44

Total costs shown here are significantly higher than the team costs obtained from ATC. Costs are distributed so that the overhead percentage will be identical. About 13% of the overhead consists of the UNOCHA costs, and another 2-3% is META expenses. ATC overhead could thus be 28-29%. De-mining accidents costs are added to ATC costs on top of this at the rate of US$ 4.5 per team hour for manual teams. These are the basic data for the calculations in Table 11.8, where survey costs are also included.

Annex 3: Cost-Benefit Case Studies

Case Study	Provinces, regions	Land type	Human loss	Land output	Animal loss	Clearance cost	Technique	CB-Ratio
Case Study V	Kandahar, Zabul, Oruzgan	Irrigation	914	7584		279	Dogs	29,5
Case Study III	Logar, Wardak	Irrigation	914	3803		279	Dogs	15,9
Case Study IV	Nangarhar, Laghman, Kunar	Irrigation	914	3069		279	Dogs	13,3
Case Study V	Kandahar, Zabul, Oruzgan	Agriculture	610	2533	14	250	Dogs	11,6
Case Study IX	Kandahar, Laghman, Kabul	Roads	914	2207	14	306	Dogs	9,2
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Irrigation	914	1854		279	Dogs	8,9
Case Study X	Other provinces except Case IX	Roads	914	1983	14	306	Dogs	8,5
Case Study VII	Helmand; Nimroz	Irrigation	914	1422		279	Dogs	7,4
Case Study V	Kandahar, Zabul, Oruzgan	Irrigation	914	7584		1041	Manual	7,2
Case Study VIII	Herat, Badghis, Farah	Irrigation	914	1356		279	Dogs	7,1
Case Study III	Logar, Wardak	Agriculture	610	1272	14	250	Dogs	6,6
Case Study VI	Ghazni, Paktika, Paktia	Irrigation	914	1071		279	Dogs	6,1
Case Study IV	Nangarhar, Laghman, Kunar	Agriculture	610	1027	14	250	Dogs	5,6
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Agriculture	610	622	14	250	Dogs	4,0
Case Study V	Kandahar, Zabul, Oruzgan	Irrigation	914	7584		1744	Mechanical	3,9
Case Study III	Logar, Wardak	Irrigation	914	3803		1041	Manual	3,5
Case Study VII	Helmand, Nimroz	Agriculture	610	478	14	250	Dogs	3,4
Case Study VIII	Herat, Badghis, Farah	Agriculture	610	457	14	250	Dogs	3,3
Case Study I	Northern Region all provinces	Irrigation	914	272		279	Dogs	3,3
Case Study VI	Ghazni, Paktika, Paktia	Agriculture	610	360	14	250	Dogs	2,9
Case Study IV	Nangarhar, Laghman, Kunar	Irrigation	914	3069		1041	Manual	2,8
Case Study I	Northern Region all provinces	Agriculture	610	107	14	250	Dogs	1,9
Case Study III	Logar, Wardak	Irrigation	914	3803		1744	Mechanical	1,7
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Irrigation	914	1854		1041	Manual	1,7
Case Study V	Kandahar, Zabul, Oruzgan	Agriculture	610	2533	14	1336	Manual	1,4
Case Study IV	Nangarhar, Laghman, Kunar	Irrigation	914	3069		1744	Mechanical	1,3
Case Study VII	Helmand; Nimroz	Irrigation	914	1422		1041	Manual	1,2
Case Study VIII	Herat, Badghis, Farah	Irrigation	914	1356		1041	Manual	1,2
Case Study IX	Kandahar, Laghman, Kabul	Roads	914	2207	14	1599	Manual	1,0
Case Study VI	Ghazni, Paktika, Paktia	Irrigation	914	1071		1041	Manual	0,9
Case Study X	Other provinces except Case IX	Roads	914	1983	14	1599	Manual	0,8
Case Study XI	Kabul, Kandahar	Residential	914	5000		3361	Manual	0,8
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Irrigation	914	1854		1744	Mechanical	0,6
Case Study V	Kandahar, Zabul, Oruzgan	Agriculture	610	2533	14	1995	Mechanical	0,6
Case Study III	Logar, Wardak	Agriculture	610	1272	14	1336	Manual	0,4
Case Study VII	Helmand; Nimroz	Irrigation	914	1422		1744	Mechanical	0,3
Case Study VIII	Herat, Badghis, Farah	Irrigation	914	1356		1744	Mechanical	0,3
Case Study I	Northern Region all provinces	Grazing	305	16	14	262	Community	0,3
Case Study VIII	Herat, Badghis, Farah	Grazing	305	15	14	262	Community	0,3
Case Study V	Kandahar, Zabul, Oruzgan	Grazing	305	14	14	262	Community	0,3
Case Study VII	Helmand, Nimroz	Grazing	305	13	14	262	Community	0,3
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Grazing	305	12	14	262	Community	0,3
Case Study III	Logar, Wardak	Grazing	305	11	14	262	Community	0,3
Case Study IV	Nangarhar, Laghman, Kunar	Grazing	305	11	14	262	Community	0,3
Case Study VI	Ghazni, Paktika, Paktia	Grazing	305	10	14	262	Community	0,3

Case Study	Provinces, regions	Land type	Human loss	Land output	Animal loss	Clearance cost	Technique	CB-Ratio
Case Study IV	Nangarhar, Laghman, Kunar	Agriculture	610	1027	14	1336	Manual	0,2
Case Study IX	Kandahar, Laghman, Kabul	Roads	914	2207	14	2563	Mechanical	0,2
Case Study I	Northern Region all provinces	Grazing	305	16	14	275	Dogs	0,2
Case Study VIII	Herat, Badghis, Farah	Grazing	305	15	14	275	Dogs	0,2
Case Study V	Kandahar, Zabul, Oruzgan	Grazing	305	14	14	275	Dogs	0,2
Case Study VII	Helmand, Nimroz	Grazing	305	13	14	275	Dogs	0,2
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Grazing	305	12	14	275	Dogs	0,2
Case Study III	Logar, Wardak	Grazing	305	11	14	275	Dogs	0,2
Case Study IV	Nangarhar, Laghman, Kunar	Grazing	305	11	14	275	Dogs	0,2
Case Study VI	Ghazni, Paktika, Paktia	Grazing	305	10	14	275	Dogs	0,2
Case Study I	Northern Region all provinces	Irrigation	914	272		1041	Manual	0,1
Case Study VI	Ghazni, Paktika, Paktia	Irrigation	914	1071		1744	Mechanical	0,1
Case Study X	Other provinces except Case IX	Roads	914	1983	14	2563	Mechanical	0,1
Case Study XI	Kabul, Kandahar	Residential	914	5000		5749	Mechanical	0,0
Case Study III	Logar, Wardak	Agriculture	610	1272	14	1995	Mechanical	0,0
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Agriculture	610	622	14	1336	Manual	-0,1
Case Study XII	Other provinces except Case XI	Residential	914	2000		3361	Manual	-0,1
Case Study IV	Nangarhar, Laghman, Kunar	Agriculture	610	1027	14	1995	Mechanical	-0,2
Case Study VII	Helmand, Nimroz	Agriculture	610	478	14	1336	Manual	-0,2
Case Study VIII	Herat, Badghis, Farah	Agriculture	610	457	14	1336	Manual	-0,2
Case Study VI	Ghazni, Paktika, Paktia	Agriculture	610	360	14	1336	Manual	-0,3
Case Study I	Northern Region all provinces	Irrigation	914	272		1744	Mechanical	-0,3
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Agriculture	610	622	14	1995	Mechanical	-0,4
Case Study VII	Helmand, Nimroz	Agriculture	610	478	14	1995	Mechanical	-0,4
Case Study I	Northern Region all provinces	Agriculture	610	107	14	1336	Manual	-0,5
Case Study VIII	Herat, Badghis, Farah	Agriculture	610	457	14	1995	Mechanical	-0,5
Case Study XII	Other provinces except Case XI	Residential	914	2000		5749	Mechanical	-0,5
Case Study I	Northern Region all provinces	Grazing	305	16	14	673	Manual	-0,5
Case Study VIII	Herat, Badghis, Farah	Grazing	305	15	14	673	Manual	-0,5
Case Study V	Kandahar, Zabul, Oruzgan	Grazing	305	14	14	673	Manual	-0,5
Case Study VII	Helmand, Nimroz	Grazing	305	13	14	673	Manual	-0,5
Case Study VI	Ghazni, Paktika, Paktia	Agriculture	610	360	14	1995	Mechanical	-0,5
Case Study II	Parwan, Kabul, Kapisa, Bamyan	Grazing	305	12	14	673	Manual	-0,5
Case Study III	Logar, Wardak	Grazing	305	11	14	673	Manual	-0,5
Case Study IV	Nangarhar, Laghman, Kunar	Grazing	305	11	14	673	Manual	-0,5
Case Study VI	Ghazni, Paktika, Paktia	Grazing	305	10	14	673	Manual	-0,5
Case Study I	Northern Region all provinces	Agriculture	610	107	14	1995	Mechanical	-0,6