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ENVIRONMENTAL ASSESSMENT FOR THE IDENTIFICATION OF A PASTORAL RESOURCE ASSESSMENT AND MONITORING COMPONENT FOR THE NATIONAL PROGRAMME FOR RANGE REHABILITATION AND DEVELOPMENT

FINAL REPORT

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ENVIRONMENTAL ASSESSMENT FOR THE IDENTIFICATION OF A PASTORAL RESOURCE ASSESSMENT AND MONITORING COMPONENT FOR THE NATIONAL PROGRAMME FOR RANGE REHABILITATION AND DEVELOPMENT, JORDAN

SUMMARY

1. The Hashemite Kingdom of Jordan has a land area of some 90,000 km^2 and a human population of nearly 4 million. Of the entire land area, less than 5% is generally considered to be arable and most of the rest can be regarded as 'rangeland', which is widely perceived to be under serious threat from overgrazing and degradation.

2. Livestock numbers, predominantly those of small ruminants, appear to have increased markedly in recent years. This is thought to have been, at least in part, due to the availability of subsidised animal feeds, which has led to the widespread use of imported wheat and barley for dry season animal feeding. As a result, stocking rates have risen to unprecedented levels. It should be noted, however, that feed subsidies have recently been phased out, although it is not yet clear what impact this has had on livestock numbers. In addition the rangeland is being encroached upon as extensive farming becomes more widespread in areas unsuited to arable cropping. This situation has been compounded by the fact that traditional seasonal livestock movement patterns are breaking down.

3. In 1991, an IFAD reconnaissance Mission identified the potential for establishing a "Range Improvement Project", which subsequently led to the preparation of the proposed National Programme for Range Rehabilitation and Development (NPRRD). The Report sets out the goals and objectives of a Development Programme to address the problem in three phases: a precondition phase consisting of adjustment, research, education and training; a de-stocking-based resource recovery phase, involving the development of commercial feed production and an emergency feed supply; and a sustainable feed, livestock and rangeland development phase. The approach taken is that long-term rangeland recovery should be the focal point of possible IFAD assistance, during which the livestock sub-sector would be structurally transformed.

4. Also emphasised in the Formulation Report is the need for *'defining appropriate land use'*. This entails assessing available resources, and using the results from these baseline estimates to help identify which areas are best suited to land uses, such as grazing, extensive cropping, and irrigation. Accordingly, the Report recommends the establishment of a Pastoral Resource Assessment and Monitoring Component, that should be integral to all three Phases. This should, in the first instance, assess and evaluate current resources, identify gaps in existing knowledge, and then monitor these resources, so that the impact of the Development Programme can be evaluated objectively.

5. There is a wealth of data and skills available in Jordan, so much of the information and expertise required for an effective assessment of pastoral resources is already accessible. It is, however, dispersed amongst a wide range of government and other institutions, and there is currently little co-ordination, or exchange of information between the various organisations.

6. It is therefore proposed that a special Unit be established for Pastoral Resource Information, Monitoring and Evaluation (PRIME). The Unit would be responsible for collecting, collating, and integrating all information relating to rangelands, livestock, and land-use currently available in Jordan. This would be undertaken through formal collaborative agreements within government and other institutions. Where necessary, ancillary studies would be commissioned to fill information gaps, and obtain additional information, as required. Supervision, equipment and training would be provided, where needed. In order to minimise start-up costs, such studies would be achieved through building on planned or existing projects, where practical, and by strengthening or expanding existing national capabilities.

7. Three categories of studies would be undertaken:

Range Assessment and Monitoring Studies through which the requisite data concerning rangeland distribution, seasonal availability, production and quality would be brought together. Past and current trends in rangeland extent would also be assessed. Much of these data would be acquired by remote sensing techniques, which need extensive ground truthing to validate and interpret reliably. Models of forage biomass production would be developed and refined, and pilot studies would be set up to experimentally assess long term benchmark data on sustainable grazing levels;

Soils, Water and Land Use Evaluation and Mapping Studies which would primarily investigate the suitability of land for rangeland or cropland use, and its potential for forage production. This would be done by monitoring soil water balance and erosion effects; identifying and assessing cultivation levels, trends and distributions; assessing the effects of cultivation on rangeland production potential; and detailed soil mapping.

Livestock Related Studies designed to establish levels and patterns of resource utilisation by livestock, verify existing livestock population data, and establish the true state of animal health in the country. This would be accomplished by assessing animal numbers in relation to the distribution of rangeland vegetation and cropland at different times of year, and by strengthening of several existing institutions. Various socio-economic aspects of livestock management in remote regions would also be assessed.

8. Once the initial pastoral resource assessment had been achieved, PRIME's subsequent activities would be directed at: refining the primary database; building national capacity to ensure sustainability of the Unit; and conducting more detailed studies associated with specific local interventions.

9. PRIME would also commission a series of socio-economic surveys to be implemented by collaborating institutions and consultants, and oversee the collation and analysis of information obtained from such studies. The objective of these activities would be to identify those elements of the rural population most susceptible to the impact of rangeland degradation; defining their geographical locations; and thus providing an objective basis for targeting inputs and activities for poverty alleviation.

10. A factor mitigating against action to save Jordan's rangeland is that the public is generally ill-informed about the condition and dynamics of nearly 90% of their land resources. If rangeland rehabilitation is to have any chance of success, this situation must change, and the population at large must be made aware of the dangers of inaction.

11. This can only be achieved if real attempts are made to provide and disseminate reliable information through whatever means are available - including community awareness and training, extension and communication units, and mass media campaigns. To this end, PRIME would design and supervise implementation of a national awareness programme to: raise the profile of rangelands and arid land development, both amongst pastoralists, themselves, and the wider general public; identify and focus in on the problems that need to be addressed; and highlight the consequences of neglect and misuse.

12. The proposed Project would run for a period of 5 years, which is considered the optimum time necessary for establishing reliable data on national trends in rangeland use and status. An alternative would be to consider funding the project over a three year period, with the costs for PY4 and PY5 being incorporated into the National Programme for Range Rehabilitation and Development. Total project cost for the three year period would amount to US$ 4.98 million (JD 3.47 million).

TABLE OF CONTENTS

LIST OF TABLES, FIGURES AND MAPS

ACRONYMS AND UNITS

ACSAD	Arab Centre for Studies in Arid Zones and Dry Lands
AIFR	Arabic Institute for Forests and Range
ARTEMIS	African Real Time Monitoring and Information System
AVHRR	Advanced Very High Resolution Radiometer
BRDP	Badia Research and Development Programme
^{o}C	Degrees Centigrade
CCD	Cold Cloud Duration
CORD	Centre for Overseas Research and Development, University of Durham, UK
DBMS	Data Base Management System
DM	Dry Matter
DoS	Department of Statistics
EC	European Community
EOS	Earth Observation Satellite
ERGO	Environmental Research Group Oxford Ltd
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FMD	Foot and Mouth Disease
g/cm^3	Grammes per cubic centimetre
GEF	Global Environment Facility
GEMI	Global Environment Monitoring Index
GIS	Geographic Information System
GoJ	Government of Jordan
GPS	Global Positioning
ha	Hectare
HCST	Higher Council for Science and Technology
HTS	Hunting Technical Services Limited
IBRD	International Bank for Reconstruction and Development (The World Bank)
ICARDA	International Centre for Agricultural Research in Dryland Areas
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund
IUCN	International Union for the Conservation of Nature
JCO	Jordan Co-Operative Organisation
JD	Jordanian Dinar
JOSCIS	Jordan Soil and Climatic Information System
kg	Kilogramme
km	Kilometre
LUT	Land Utilisation Types
METAP	Mediterranean Environmental Technical Assistance Program
mm/h	Millimetres per Hour
MMRAE	Ministry of Municipalities and Rural Affairs & the Environment
MoA	Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautical and Space Administration
NCARTT	National Centre for Agricultural Research and Technology Transfer
NDVI	Normalised Difference Vegetation Index
NFC	National Forecasting Centre
NIC	National Information Centre
NIS	National Information System
NOAA	National Oceanographic and Atmospheric Administration
NPRRD	National Programme for Rangeland Rehabilitation and Development
NRI	Natural Resources Institute, UK
NRSC	National Remote Sensing Centre, UK
ODA	Overseas Development Administration, UK
PM	Project Manager
PPR	Peste des Petits Ruminants
PPS	Probability Proportional to Size
PRIME	Pastoral Resources, Information, Monitoring and Evaluation Unit
PVI	Proportional Vegetation Index
PY	Project Year
QAF	Queen Alia Fund
RJGC	Royal Jordanian Geographic Centre
RS	Remote Sensing
RSCN	Royal Society for the Conservation of Nature

SAP	Structural Adjustment Programme
SLUD	Soils and Land Use Division of the Ministry of Agriculture
SPOT	Système pour l'Observation de la Terre
SRF	Systematic Reconnaissance Flight
SPSS	Statistical Package for the Social Sciences
SSLRC	Soil Survey and Land Research Centre, University of Cranfield, UK
TALA	Trypansomiasis and Land Use in Africa Research Project
TAMSAT	Tropical Applications Satellite
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
US$	United States Dollar
WAJ	Water Authority of Jordan
WFP	World Food Programme
WMO	World Meteorological Organisations

PERSONNEL AND ACKNOWLEDGEMENTS

The Mission members were:

Dr. William Wint (Mission Leader): Resource Assessment and Environmental Monitoring Specialist;
Mr Alan Stapleton: Soils and Land Use Evaluation and Monitoring Specialist;
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The Mission's Contact Officer in IFAD was Dr Nessim Ahmad, Environmental Technical Advisor

During the course of the mission an extensive series of discussions were held with a wide range of Governmental and Non-Governmental Organisations and International Agencies, including various Departments within the Ministry of Agriculture; National Council for Agricultural Research and Technology Transfer; Ministry of Planning and its Department of Statistics; Department of Environment; Department of Meteorology; Department of Lands and Survey; Ministry of Water and Irrigation; Royal Jordanian Geographical Centre; the Badia Research and Development Programme and the National Information Centre at the Higher Council for Science and Technology; Faculty of Agriculture, University of Jordan; Jordanian Co-Operative Organisation; Queen Alia Fund; Noor al Hussein Foundation; Royal Society for the Conservation of Nature; ICARDA; GTZ; ODA; UNDP; EU; and USAID.

The Mission expresses its thanks and appreciation for the valuable assistance, advice and co-operation given to its members by these personnel and institutions, and gratefully acknowledges the enthusiasm and spirit of co-operation with which discussions were held.

I. INTRODUCTION AND BACKGROUND TO THE MISSION

1. The Hashemite Kingdom of Jordan has a land area of some 90,000 km^2 and a human population of nearly 4 million. Of the entire land area, less than 5% is generally considered to be arable and most of the rest can be regarded as 'rangeland', which is widely perceived to be under serious threat from overgrazing and degradation.

2. Livestock numbers, predominantly those of small ruminants, appear to have increased markedly in recent years. This is thought to have been, at least in part, due to the availability of subsidised animal feeds, which has led to the widespread use of imported wheat and barley for dry season animal feeding. As a result, stocking rates have risen to unprecedented levels. Since 1970, numbers appear to have doubled, to reach their current estimated levels of 1.8 million sheep, 0.7 million goats and 20-35 thousand each of cattle, horses and camels. There is also reputed to be a large seasonal influx of small ruminants from neighbouring countries.

3. It should be noted, however, that feed subsidies have recently been phased out, although it is not yet clear what impact this has had on livestock numbers.

4. In addition the rangeland is being encroached upon as extensive farming becomes more widespread in areas unsuited to arable cropping. Estimates vary, but one indicates a 230% increase in extensive 'field crops' between 1981 and 1990[1].

5. This type of farming is often embarked upon to lay claim to lands, rather than for crop production, and as such has been termed 'pseudo-cropping', though some economic benefit may accrue to the farmer through the sale of residues as livestock fodder during the early summer.

6. Much of the cropping in the north and east of the country is fed by drip irrigation, supplied from artesian wells, which are becoming more saline due to high extraction rates. In the south, however, fossil water is being used on substantial irrigation schemes situated in otherwise arid areas. The residues from these crops are a significant source of dry season fodder for the livestock in that region.

7. This situation has been compounded by the fact that traditional seasonal livestock movement patterns are breaking down. True nomadic pastoralism has all but disappeared, and approximately 70% of Jordan's livestock are now kept under transhumant management systems. Since many pastoralists now truck animals, feed and water to known grazing areas, even previously inaccessible regions are in danger from over-utilisation.

8. Other threats to the rangeland include plastic waste from drip-irrigation, and the uprooting of shrubs for firewood. Whether the range can fully 'recover' is unknown due to an absence of baseline data, though the condition of protected areas and border zones suggests that biodiversity and standing biomass can be much increased with proper management.

9. The perceived decline in rangeland production and plant diversity is mirrored by a fall in faunal biomass and diversity. Wildlife was, until the relatively recent past, fairly abundant and diverse, but is now in serious decline, largely because of hunting and the deterioration of natural grazing.

[1] Cited as Qasem et al. (1993) in National Programme for Range Rehabilitation and Development: Formulation Report prepared by IFAD (1993). No further details given.

10. The situation appears to have deteriorated substantially in recent years. Overall, rangeland productivity is thought to have declined by up to 50%, and to be declining at a rate of 3-5% per year. Should this continue in the medium to long-term, the fear is that rangeland degradation will become both permanent and universal.

11. Given that it costs the average pastoralist 0.1 Jordanian Dinar (JD) per day to feed each animal with grain or crop residues, and the rangeland is usually grazed for two to three months per year, the natural grazing represents 9JD per animal per year. Assuming an average herd size of 200, this adds up to 1800JD (US$2600) per herd owner per annum. The current degradation (at 3-5% per year) is thus increasing the feed costs for the average livestock owner by US$80-130, annually.

12. Thus, if the natural pasture all but disappears, it would represent an average loss to pastoralists of some US$10 per animal per year in lost grazing (equivalent nationally to more than US$20 million per annum, assuming present livestock population levels), which would have to be replaced by imported feeds, or local forage production.

13. The sectors of the population potentially most affected by accelerated range degradation are unlikely to be those more affluent stock owners with large herds, and substantial off farm interests. Rather they are likely to be those most reliant on the land - i.e. those in remote areas, with few sources of income other than livestock or small scale agriculture.

14. As a result, any activities designed either to identify areas of potential degradation, or remedial measures in such areas, are likely to, *de facto,* target the poorer, more economically vulnerable pastoralists. Failure to implement such activities, in the face of a continuing decline in grazing resources, will therefore tend to concentrate any adverse effects on those least able to compensate for them.

15. Continuing degradation may also lead to serious hydrological consequences - rainfall run-off patterns may be seriously affected by the lack of vegetation, leading to flash floods, increased erosion, and significantly reduced groundwater recharge. Biodiversity of the natural flora and fauna would also be further reduced.

16. The rangeland which is still available for producers, and for which it may be possible to reverse the process of degradation (the Badia), receives a mean annual rainfall of less than 200 mm, and much of it, less than 50 mm (see Appendix 4, Maps 1 and 10). Rainfall is extremely patchy and variable from year to year, which makes the range more vulnerable to overgrazing. Annual precipitation appears to have remained fairly constant in recent decades, though it is widely believed to be declining substantially. It is this perceived decline in rainfall, rather than overgrazing, that is often cited as the cause of the rangeland degradation.

17. Initiatives for the conservation of the Jordanian rangelands are not new - indeed there is a long history of reports identifying the problems and proposing solutions. A number or interventions have been implemented, including the establishment of numerous grazing, forest and nature reserves. The geographical extent of these managed resource areas remains small in comparison with the size of the country, and their overall impact has been limited.

18. Recent range related projects include: Development of Forestry and Rangeland (WFP); Forestry and Food Security in the Mediterranean and Near East Region (Italy), Strengthening Forest and Range Management (UNDP); Development of Forest Resources for Environment Protection and Food Security in Arid and Semi-Arid Areas (Japan); Zarqua River Basin

Project (Islamic Bank, Saudi Fund, Arab Fund, Kuwait Fund); Hamad Basin Project (Arab Fund); Regional Rangeland Project (UNDP); and Soil Mapping and Land Use Project (EU).

19. In 1990, a World Bank Livestock Sub-Sector Review Mission identified the need for establishment of a Pastoral Development Unit to co-ordinate range and livestock related activities, and promote the formation of rural pastoral associations (IBRD, 1990). The Mission was unable to discover the outcome of these recommendations, but found no evidence of any substantial actions derived from them.

20. In 1991, an IFAD reconnaissance Mission identified the potential for establishing a "Range Improvement Project", which subsequently led to the preparation of the proposed National Programme for Range Rehabilitation and Development (NPRRD). The Formulation Report provides overviews of the Programme and sectoral context; the agro-ecological, edaphic and hydrological characteristics of the Programme area; and gives details of the current status of the livestock industry (IFAD, 1993). Amongst its major conclusions are that the livestock system in Jordan is no longer rangeland based, and that livestock numbers must be reduced dramatically if the rangelands are to survive and livestock are to be sustainably managed in the long term.

21. The Report sets out the goals and objectives of a Development Programme to address the problem in three phases: a precondition phase consisting of adjustment, research, education and training; a de-stocking-based resource recovery phase, involving the development of commercial feed production and an emergency feed supply; and a sustainable feed, livestock and rangeland development phase. The approach taken is that long-term rangeland recovery should be the focal point of possible IFAD assistance, during which the livestock sub-sector would be structurally transformed. This process would make major interventions to restore forage productivity of rangelands either unnecessary, or achievable through implementation of more appropriate policies, and the provision of financial and other incentives.

22. The Formulation Report states that little range vegetation and soil information is available from before 1980, and that which is available tends to be patchy and of limited value. The quality of more recent information is similar. *'Much comment has been made on the condition and trend of the rangelands. The rangeland are said to have degraded considerably over the recent decades, and as a result threaten the ecological stability of the area. Unfortunately there is little or no direct objective data available to support, or disprove, these observations. Most of the extreme interpretations are emotive and do not allow for the resilience of the ecosystem which has been modified by grazing for millennia'.*

23. Such 'certainty' about the state of the rangelands is not new, as exemplified by the following statement written in 1954[2]: *'I have not the least doubt.... that there is a major task ahead of the responsible Jordanians to re-educate the thinking of the large group of people to stop the present irregular and injurious practice relating to land use, which accelerates soil erosion, loss of water and extermination of wild life and would at last bring starvation and catastrophe to the immensely increasing population of Jordan'* (Salti, 1954).

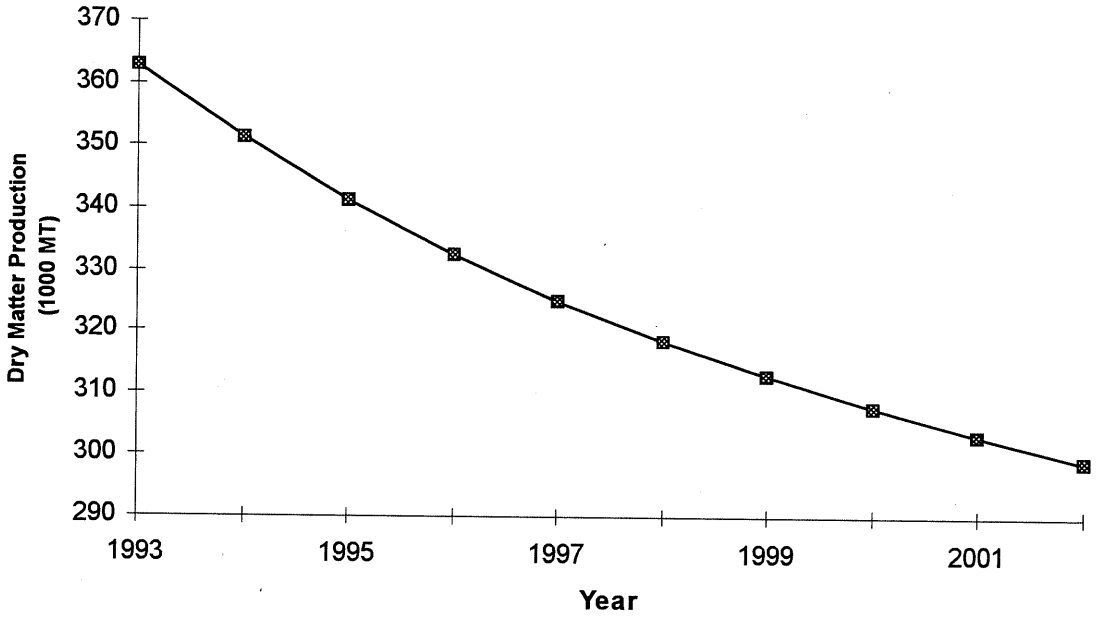
24. Forty years later, the situation appears to be similar - the rangelands are still perceived by many professionals to be in state of near terminal decline, as illustrated by the summary presented earlier in this section. The Formulation Report's position, however, is somewhat less

[2] From a paper presented by Y. Salti, Director of Forests, Amman, at the UNESCO Symposium on the Protection and Conservation of Nature in the Near East, Beirut, 1954

dramatic, but it does predict a steady decrease in rangeland dry matter production, amounting to some 20% over ten years (Figure 1).

25. The Formulation Report concludes that *'there is currently no objective information on the condition, dynamics and trend of the rangeland. Such information is essential to the design of a rangeland destocking programme and also for the assessment of livestock carrying capacities. Regular updates of resource inventory would be required so that any environmentally damaging trends can be identified as soon as possible and so that the recommendations of livestock carrying capacities can adequately reflect the naturally dynamic nature of the rangeland. This would be a major undertaking.'*

Figure 1: Formulation Mission Estimates of Rangeland Productivity (1993-2002)



26. The Report also states that the priority of rangelands in Jordan's political agenda is low - though this is beginning to change. The impending Environment Act (see Annex 1) calls for *'a National plan to survey and classify the Kingdom lands according to their uses on the basis of fertility, agricultural density, location according to availability of irrigation sources ....'*. The Act also requires Government to *'identify the causes and factors behind soil erosion and desertification and take procedures necessary to stop erosion and desertification...'*.

27. Another factor mitigating against successful action to save Jordan's rangeland is that the public is generally ill-informed about the condition and dynamics of nearly 90% of their land resources. If rangeland rehabilitation is to have any chance of success, this situation must change, and the population at large must be made aware of the dangers of inaction. This can only be achieved if real attempts are made to provide and disseminate reliable information through whatever means are available - including community based awareness and training, extension and communication units, and mass media campaigns.

28. Also emphasised in the Formulation Report is the need for *'defining appropriate land use'*. This entails assessing available resources, and using the results from these baseline estimates to help identify which areas are best suited to land uses, such as grazing, extensive cropping, and irrigation.

29. The forthcoming United Nations Convention to Combat Desertification, due to come into effect in 1997 (see Appendix 1), defines desertification as '*as land degradation in arid, semi-arid, and dry sub-humid areas, caused primarily by human activities and climatic variations. It does not refer to the expansion of existing deserts. Degradation occurs because dryland ecosystems, which cover more than one third of the world's land area, are extremely vulnerable to over-exploitation and inappropriate land use. Poverty, political instability, deforestation, overgrazing, and bad irrigation practices can all undermine the land's fertility*'. This describes, with almost uncanny accuracy, the perceived state of the rangelands in Jordan.

30. The Convention states that programmes that would be implemented by countries party to it '*must adopt a democratic, bottom-up approach. They should emphasise popular participation and the creation of an enabling environment designed to allow local people to help themselves to reverse land degradation. Governments would remain responsible for creating this enabling environment. They must make politically sensitive changes, such as decentralising authority, improving land-tenure systems, and empowering women, farmers, and pastoralists. They should also permit non-governmental organisations to play a strong role in preparing and implementing the action programmes. In contrast to many past efforts, these action programmes must be fully integrated with other national policies for sustainable development. They should be flexible and modified as circumstances change.*'

31. It continues: '*The Convention's action programmes would be developed through consultations among affected countries, donors, and intergovernmental and non-governmental organisations. This process would improve co-ordination and channel development assistance to where it can be most effective. It would also produce partnership agreements that spell out the respective contributions of both affected and donor states and of international organisations.*

Developed countries are expected to encourage the mobilisation of substantial funding for the action programmes. They should also promote access to appropriate technologies, knowledge, and know-how. The need for co-ordination among donors and recipients is stressed because each programme's various activities need to be complementary and mutually reinforcing.'

32. Reliable information about Jordan's rangelands and its condition is lacking, and there is therefore a strong case to be made for the establishment of a baseline assessment and monitoring programme before any serious attempt can be made to improve rangeland productivity. It is essential to know whether the rangelands are actually being destroyed, and, if so, to have sufficient understanding to evolve appropriate mitigation strategies.

33. Accordingly, the Report recommends the establishment of a Pastoral Resource Assessment and Monitoring Component, that should be integral to all three Phases. This should, in the first instance, assess and evaluate current resources, identify gaps in existing knowledge, and then monitor these resources, so that the impact of the Development Programme can be evaluated objectively.

34. The purpose of the current report is, therefore, to present a detailed design for a project in support of Phase I, which would strengthen the process of establishing appropriate conditions for implementation of subsequent phases of the proposed Development Programme.

35. The report is based on information collected during a Mission executed in June and July 1995, and is divided into six Sections as follows:

- I. **Introduction and Background** (the Present Section);
- II. A summary of relevant **Information and Expertise available** in Jordan;
- III. **Rationale, Objectives and Design** of the proposed Project, including a summary of proposed activities, costs and environmental impact;
- IV. **Content** of the proposed Project's Sub-Components;
- V. **Project Implementation, Issues and Risks;**
- VI. **References.**

36. There follow a number of Appendices dealing with specific topics discussed in the main body of the Report, and a series of Colour Maps.

37. The Main Report has been abstracted and compiled from detailed information contained in five supporting Annexes as follows:

- Annex 1: Institutional and Socio-Economic Matters
- Annex 2: Rangeland
- Annex 3: Soils and Land Use
- Annex 4: Livestock
- Annex 5: Financial and Economic Analysis

II. INFORMATION AND EXPERTISE AVAILABLE

38. The following Section consists of a review of the information and expertise currently available in Jordan. It covers a number of topics, specifically: The National Economy; Information Exchange; Remote Sensing and GIS; Rangelands; Soils and Land Use; Climate, Rainfall and Hydrological Data; Socio-economic Information; Public Awareness and Networking; and Livestock.

39. A substantial portion of the Section, particularly that dealing with Rangeland, is devoted to the evaluation of technological expertise in the fields of Remote Sensing and Data Collection. This is because, in the Mission's opinion, there is a dearth of consistent and verified information in this area, and the most cost effective way to obtain the data required is by using such methodologies. It is therefore viewed as essential to assess the in-country capabilities to collect and collate remotely sensed data, and to evaluate the expertise available to make the best use of these techniques in relation to the other types of factual material required.

THE NATIONAL ECONOMY

An Overview

40. Jordan is highly dependent on imported oil. The national economy is characterised by a dominant service sector (tourism, transport, finance and insurance) accounting for about 60% of GDP. Around 70% of total export earnings are derived from the production of chemicals and the mining of phosphate and potassium.

41. Up to 1982, Jordan had the benefit of favourable economic conditions due to the Gulf States' increase in oil income, particularly through Arab aid and remittances from foreign workers. The sharp drop in oil prices in 1982 resulted in a gradual reduction in demand for Jordanian goods and services, and in the flow of grants. The decline in foreign receipts could not interminably be compensated for by external borrowings to keep the economy expanding. In 1988 the Jordanian Dinar (JD) was devalued by 50%, whilst the growth in GDP fell by 2.5% in the same year.

42. The implementation of a Structural Adjustment Programme (SAP) 1989-93, concluded with the IMF in April 1989, has had some positive effects in terms of narrowing the budget deficit, improving the trade balance, increasing domestic savings, and reducing inflation from a peak of over 25% in 1988 to about 16%. A second agreement was signed in October 1991, targeted at increasing real growth; reducing the budget and current account deficit; reducing public expenditure; and lowering the rate of inflation through tighter control of the money supply. This second SAP covers a seven year period, over which the IMF expects the government deficit, excluding grants, to drop from its 1991 level of 18%, to 5% by 1998.

43. The return of about 300,000 Jordanians and Palestinians from the Gulf area, together with some 800,000 non-Jordanian evacuees, fleeing from Iraq and Kuwait, has compounded the country's economic problems. This adverse situation, however, elicited substantial foreign aid (grants and soft loans in 1991 amounted to US$1.2 billion), which helped the economy to grow by 1% in 1991.

44. The Gulf crisis undermined the efforts of SAP. GDP declined by 8% for the whole of 1990. The per capita GNP fell from US$ 2,060 in 1986 to US$ 920 in 1990. The rate of unemployment is estimated to have reached 25% of the work force in 1991. Jordan was forced to place a moratorium on payment of its rescheduled debts.

45. By the end of 1991, the economy began to show some signs of recovery. GDP registered a modest growth rate of 1%; trade deficit fell by about 7%; and inflation came down to about 10% from 16% in 1990. The construction sector witnessed a boost, primarily to meet the increasing demand for housing, schools and other facilities for the returnees. The resumption of the Gulf markets and the penetration of new markets, although limited, improved export performance. A proportion of returnees invested their savings in small enterprises, which has led to an increase in retail trading activities. A rise in tourism and of the transportation and industrial sectors was also noted.

46. Foreign aid was, and still is, instrumental in enabling Jordan to address many of its economic and social problems. Although the size of such foreign aid is likely to decline from its level during 1991, the shortfall it produces is expected to be compensated for, at least in part, by progressive improvement in relations with neighbouring states. The GoJ is likely to remain highly dependent on concessionary foreign assistance for investments in agriculture and infrastructure in the coming decade.

47. Recent negotiations with the Paris Club have reported Jordan's success in securing a 60% reduction of its foreign commercial debt. Under the terms of the agreement reached with 80 banks, US$895 million of commercial debt are to be rescheduled.

Agricultural Sector Reform

48. Structural adjustment of the agricultural sector has been a subject of discussion between the GoJ and the World Bank for a number of years. In October 1990, the World Bank presented a memorandum which set out policy areas and objectives for reform, as well as the agenda for continuing discussion and dialogue. In December 1994, Government reached agreement with the World Bank on an Agricultural Sectoral Adjustment Loan. The World Bank is the lead institution of a consortium that includes the IMF and bi-lateral sources. The loan became effective in early 1995. Its reforms centre around three broad themes, each carrying its own agenda:

- **Market Led Modernisation;**
- **Efficient Resource Use; and**
- **Minimal Government Intervention.**

49. The main areas for reform include:

- **Fiscal Policy.** This addresses the need to: maintain a floating exchange rate to keep exports competitive; establish and maintain commercial interest rates and to rationalise the public expenditure programme.
- **Production Subsidies.** The objective here calls for the liberalisation of input and output prices and the elimination of subsidies. It focuses on: development of realistic water prices by including operational and management costs; development of a deregulated livestock feeds market, phasing out subsidies and liberalising all cereal prices and markets.
- **Production Controls.** The elimination of cropping pattern controls on horticultural crops.
- **Marketing and Trade.** Liberalisation and deregulation of pricing agricultural produce; wholesale marketing and markets; and parastatal marketing and import operations

- **Agricultural Credit.** Reform has been suggested to ensure the sustainable availability of credit to the agricultural sector.
- **Ministry of Agriculture.** Need for strengthening and rationalisation was identified in the areas of:
  a). Policy analysis, and
  b). Research and extension, particularly in the fields of crop intensification and diversification, and on-farm water management
- **Ministry of Water and Irrigation.** Institutional strengthening to improve water resource planning and management.
- **Jordan Valley Authority.** The issues here are to improve operational efficiency and strengthen operational and management capacity and prioritise investments to focus on water conservation and the efficiency of projects.

50. As a first step in implementing these reforms GoJ has, during the first half of 1995, gradually phased out the subsidy on barley and wheat used as livestock feeds, the final subsidy element being eliminated in June 1995. The GoJ has also prepared an Agricultural Policy Charter to address necessary reforms. The initial draft document was prepared in September 1993 and has since been extensively discussed. A revised final draft has been approved by the Agricultural Council, and should soon receive final government approval.

INFORMATION EXCHANGE

51. The collection and dissemination of information in Jordan is subject to a number of legal conditions. For example, all official agricultural data is currently the responsibility of the Department of Statistics, whilst all geographic information is controlled by the Royal Jordanian Geographic Centre. In theory, any institution intending to assemble or collect data pertaining to these topics should obtain the permission of the designated authority.

52. There is, however, some flexibility in the system. For example, the Ministry of Agriculture has an agreement with the Department of Statistics allowing it to collect and process agricultural data for its own purposes, and to disseminate them where appropriate.

53. An on-going GTZ funded project is assisting in the establishment of a National Information System (NIS), co-ordinated by the National Information Centre (NIC) within the Higher Council for Science and Technology (HCST). NIC is currently preparing a data register, which would be accessible by modem, and would specify the type and location of data available in a series of nodes connected by a Wide Area Network, each covering specific fields. The system is planned to be functional by the end of 1995, and would allow any institution connected to the Network to download summary data from any node. If more detailed information is required, users would be informed of the relevant locations, and may, in certain cases, be able to access the sources via the node system.

54. If this system is implemented in its entirety, NIC would have to be informed of any major data gathering exercise, and may require the data to be provided in compatible format to the relevant node. There may also be a requirement for prior discussion with the relevant authority to identify particular information categories that should be made available.

REMOTE SENSING, GIS AND IMAGE PROCESSING

55. National Geographic Information System (GIS), film writing, map production, and image processing capabilities are concentrated within the Royal Jordanian Geographic Centre (RJGC). The expertise available is of international calibre - many of the technical personnel have spent between five and ten years in Europe as a functioning team, and have contributed to bleeding-edge technology development. The Centre's computer hardware is about to be upgraded, and will be more than adequate for most purposes. The software used includes ArcInfo and ERDAS.

56. The primary functions of the Centre have, in the past, focused on a variety of specialised aspects of remote sensing, including digitisation of national topographic maps. The scope of its activities are, however, widening considerably, and now include soil and land use mapping, vegetation mapping using NOAA, LANDSAT and SPOT satellite imagery, and satellite data processing. Several pilot projects have been carried out in recent months, including, for example, the identification of potential sites for animal feedlots and desert dams, involving satellite imagery processing and digital terrain mapping, validated by ground truthing and aerial photography. Many of these projects have been undertaken in collaboration with outside institutions, both governmental and non-governmental.

57. The RJGC does not, however, have direct access to satellite imagery, and currently has to buy the scenes required from international sources. The National Forecast Centre (NFC) at the Meteorological Department has receiving equipment for both the NOAA and METEOSAT satellite systems. NOAA images may be used to calculate indices of the cover and biomass of green vegetation at a resolution of up to 1km. METEOSAT can detect the surface temperatures of clouds and weather systems, which, with suitable ground truthing, can be calibrated to estimate rainfall at a resolution of 8km.

58. NFC can receive images on a daily basis and subject them to basic processing on site. There is little or no archiving of data; data tapes are held for a period, but are eventually re-used. To date, there has been no attempt to ground-truth the products from either the NOAA or METEOSAT systems in Jordan. Though the staff responsible are able to acquire the imagery reliably, and to perform fairly sophisticated processing procedures (e.g. compositing, vegetation index preparation) these data are presently under-used, partly through lack of demand, and partly because of inadequate data storage facilities.

59. Responsible staff from both RJGC and Meteorology repeatedly expressed their interest in expanding their activities through collaboration on a cost recovery basis.

60. The EU funded National Soil Map and Land Use Project was established in 1990 with the assistance of Hunting Technical Services Limited and the Soil Survey and Land Research Centre (Cranfield University). The staff consists of three senior soils and land use specialists, nine junior soils and land use specialists and three computer/data base specialists. The Soil and Land Use Project has now become a separate Division (SLUD) within the Department of Forestry and Range.

61. During the Project the Jordan Soil and Climatic Information System (JOSCIS) was established, which combines SPANS GIS facilities with a data base containing soils, climate and land cover information for Jordan. To this have been added various layers of external data - for example a 1:250 000 vegetation map, prepared by an FAO project in the Forestry and Range Department in 1991, which has been digitised and integrated into the SPANS database

(See Appendix 4, Map 3). Other layers include the distribution of actual and planned grazing reserves, rainfall (See Appendix 4, Maps 4 and 10), meteorological stations, and catchments.

62. Maximum use of the available information is encouraged by the Division, provided permission is sought from the relevant Ministry of Agriculture (MoA) authorities. SLUD is, however, hampered by serious funding deficiencies, particularly as regards operating costs, and lack of logistic support capability. The Division has neither effective facilities for chemical or physical analysis nor adequate equipment for field measurement of soil physical properties.

63. In addition, serious difficulties have been experienced in transferring the data to other GIS systems (e.g. ArcInfo) used in Jordan, because of outdated computer software and hardware, and insufficient training. Most of the pedologists in SLUD have had little experience in computer use, and have not been properly trained in the use of the data base, or the GIS. The GIS technicians and computer programmer have not received detailed system specific training.

64. A number of other institutions are planning to set up GIS systems in the near future - these include an EU funded project within the Faculty of Agriculture at the University of Jordan, and the Badia Research and Development Programme of the HCST, in collaboration with the University of Durham in the UK. Both projects deal with parts of the rangeland, but are not planning national coverage, and are in the earliest stages of implementation.

RANGELANDS

Overview

65. While there exists a measure of personal experience and a great deal of semi-quantitative estimation of forage productivity, firm data on rangeland plant biomass and growth relationships are scarce. There is a very limited geographical scope to the existing information, together with a lack of temporal perspective in which to view the current and developing situation. In addition, there is limited understanding of the limits of variation in plant cover and composition which can result from the interaction of a variable climate with diverse soils and hydrology, quite apart from the additional impact of domestic herbivores.

66. The rationale for the collection of good quality and timely information on pastoral resources is to enable decision-makers to plan and implement appropriate interventions for improving the livelihood of pastoral resource users. Interventions aimed at the alleviation of poverty through improved management of widespread native rangelands should be designed for maximum effectiveness with an clear understanding of the determinants of rangeland forage productivity; without such knowledge of likely vegetation response to management actions, development activities could have ineffective, or even negative consequences. A system providing accurate, up-to-date information on the pattern and trends of forage production, available on a continuous basis on a nation-wide scale, would allow the tracking of rangeland vegetative cover in response to rainfall and livestock distribution and possibly "early warning" anticipation of crop or forage production failure.

67. The concept of "degradation" in arid rangelands and the utility of attempting to define a simplistic "carrying capacity" for livestock in such regions have been an increasing focus of debate in recent years (e.g. Behnke et al. 1993, Dahlberg 1994). Because productivity is determined to a large extent by rainfall, and because rainfall is low and generally highly variable in dry lands, it is increasingly recognised that the dynamics of forage production and rangeland condition may be driven at least as much by climate as by grazing impact. Degradation is now

defined in terms of the ability of land to yield livestock products of benefit to people, as affected by both abiotic factors and use intensity.

68. Concentrated and continued grazing can have the effect of reducing the resilience of the pasture to respond to periodic shortages or abundance of rainfall. Since it may be impossible to define a realistic single figure for "carrying capacity", a more flexible approach to rangeland management is advocated, in which forage abundance is examined in relation to rainfall, soils and livestock density, with a spatial element. Interventions to improve productivity should be planned so as to take advantage of favourable environmental conditions.

69. Information from an improved system for describing and monitoring rangeland forage productivity could be used by decision makers in the Jordanian government, the private sector and other countries in the region, both by example and through internationally co-ordinated efforts at improved management of communally used rangelands.

Vegetation Mapping

70. The rangelands of Jordan have been categorised in agro-climatic zones as Highlands, Steppe and Badia, in descending order of rainfall (See Appendix 4, Maps 1 and 10). It is noted by IFAD (1993) that statistics on land use in Jordan are incomplete and often contradictory, but that it is generally accepted that some 8,340,000ha, or 95% of the total land area, is of potential use as rangeland.

71. Since 1956, a number of rather coarse grained rangeland vegetation maps have been compiled. These have been of varying precision and type, based on landscape, bioclimatic factors, and floristic composition, and were based on limited ground truthing work. The National Soil Map and Land Use Project, established in 1990 with the assistance of Hunting Technical Services Limited (HTS) and the Soil Survey and Land Research Centre (Cranfield University), developed a database of digitised maps from the early work of HTS (1956), revised in HTS (1991) and of FAO (1991) (see Appendix 4, Maps 2 and 3).

72. Depending on the mapping system chosen, the rangeland vegetation of Jordan can be cast into a variety of different vegetation zones. According to the work of Tuttle (1971), which has been taken up by Juneidi and Abu-Zanat (1993) and IFAD (1993), there are six basic rangeland zones. The rangeland classification of Hunting Technical Services (1956, 1991) provides twelve rangeland vegetation types, and the vegetation map developed by FAO (1991) describes some 120 vegetation associations.

73. The Soil and Land Use Project described and mapped soils and land use categories in Jordan based on 18 physiographic land regions (See Appendix 4, Map 7). Observations of simple floristic vegetation associations were made and a map of vegetation types, based on the HTS Rangeland Classification mapping units and four "agro-climatic" zones, as defined by climate, soils and topography, was produced (See Appendix 4, Map 1).

74. Woodlands occur in the Mediterranean region and trees are scattered in areas subject to grazing. *Poterium* scrub is found on shallower soils in this area indicating land degradation leading to replacement by dwarf scrub.

75. Steppe vegetation occurs mainly in the rainfall range 100-250mm, but is also found in wadi channels receiving runoff. Between 250-350mm, Steppe species occur in association with Mediterranean transitional species. Two major types occur, *Artemesia* Brush Steppe and

Grassland Steppe. The Brush Steppe occurs south of El Qatrana and on the escarpment and consists of *Artemesia, Retama and Salsola.* Grassland Steppe, consisting mostly of grasses, such as *Poa* and *Carex sp.*, occurs extensively in the North and more patchily on parts of the north eastern limestone plateau.

76. In the sandstone and granite desert regions, significant vegetation cover is confined to wadis, sandsheets and fans. This is an important source of grazing and browse. These areas are subject to increased moisture supply from runoff from higher areas or high infiltration and ready availability of limited amounts of soil water.

77. In the limestone and basalt deserts the major vegetation communities of value for grazing and browse are restricted to the numerous shallow wadi beds and depressions. This could provide a basis for mapping agro-ecological zones at 1:250,000 or 1:50,000 scale, and for relating present vegetation to degradation states.

78. None of these maps has been extensively checked or validated by systematic vegetation surveys, and there is a clear need to do so.

79. The Jordan Badia Research and Development Programme (BRDP), under the co-ordination of the Higher Council for Science and Technology has access to a variety of remote sensing imagery and plans to produce detailed maps of the vegetation in their study area in the north-eastern Badia (BRDP, 1994).

Rangeland Vegetation Composition and Productivity

80. The available information on rangeland composition and productivity in Jordan is extensive, but sketchy. Little work has been done in the broader rangeland areas of most of the country, apart from anecdotal reports and some semi-quantitative estimation undertaken by the IFAD (1993) Mission.

81. Detailed information is limited to 32 grazing reserves (Range Reserves established by the Ministry of Agriculture and the Jordan Co-Operative Organisation (JCO) and nature conservation protected areas (Wildlife Reserves established by the Royal Society for the Conservation of Nature (RSCN) See Appendix 4, Maps 4 and 5). Descriptions of vegetation in Nature Reserves have been undertaken by ecologists working for RSCN. Reports are available on the vegetation of some of their Nature Reserves, while others are planned for the future. The RSCN is small, but well-organised and well-funded. Its administration has clearly defined divisions for resource assessment and monitoring, reserve management and education/extension/public relations.

82. Taken together, both types of Reserve still cover a very small proportion of the total area of rangeland in Jordan. As noted by IFAD (1993), extrapolation of vegetation conditions as estimated in protected Reserves to more extensive areas of unmanaged rangeland is likely to be misleading. However, by virtue of the relative degree of control exercised over their land use, these areas have potential value as sites for regulated grazing experiments, as described below.

83. The existing Nature Reserves cover less than 1% of the total area of rangeland. Most are totally protected from grazing, either through perimeter fencing or guards, although in some areas, such as the Dana Reserve, local pastoralists still use areas within and immediately adjacent to the protected area. Their distribution is also biased towards the west, but has some

representation in the arid Badia. A number of additional ones have been proposed, including several of large area in the Steppe and the Badia, but, again, it is not clear when these might be established.

84. The existing Range Reserves also cover less than 1% of the total area of rangeland in Jordan. Within the Reserves, some 28% of the land has been planted with forage shrubs in an attempt to improve grazing conditions. Most of these Reserves have some theoretical degree of protection and/or control over grazing practices. The Reserves managed by the JCO have a better record in the latter regard. The majority are located in western Highland and Steppe areas, with few in the arid Badia. A number of additional Reserves have been proposed, including several in the Badia, but it is not clear when these might be established.

85. Data on plant species composition and biomass in Range Reserves have been collected by professional staff at the National Centre for Agricultural Research and Technology Transfer (NCARTT), and by technical staff in the Range Division of the Ministry of Agriculture. The latter datasets are generally less quantitative in nature. As noted by IFAD (1993) and confirmed by the Mission: *'reports on rangeland forage biomass production are based on generalised values, quoted without reference to the original source and it appears that most of the values reported are based on estimates, rather than on actual measurements'.*

86. Existing estimates of rangeland forage production are largely speculative, based on visual estimates, published but unattributed accounts or anecdotal reports from local herdsmen. The trends in biomass production derived from them are similarly hypothetical (see Introduction). There is a clear need for empirical testing and/or validation of the assumptions and observations.

87. In addition, it is essential to understand the range of variation present in the rangeland systems of Jordan. It is interesting to note that the study of Tadros & Salem (1993) at Lajjoun in the Steppe reported biomass production values of 240 and 910 kgDM/ha in open rangeland and Reserve, respectively, in the spring of 1992, but values of only 20 and 190 kgDM/ha, respectively, in the spring of the following year. These results emphasise the temporal variability of plant production in the dry rangelands, and the danger inherent in relying on limited data or "average values" in assessing the productivity of the dry rangelands.

88. Unfortunately, few of the other sources cited above have provided quantitative information on temporal variation in rangeland forage biomass production, either through seasons or between years. As suggested by IFAD (1993), both seasonal and inter-annual variation in production is likely to be greater in the more arid Badia, rangelands than in those of the Steppe and Highlands regions. In addition, the Steppe and Highland regions are thought to experience a bi-modal pattern of seasonal herbage production, with a major peak in the spring and a lesser one in the autumn, while in the Badia, production is uni-modal, with a single burst of productivity in the spring. Greater variation in the geographic pattern of forage production in the Badia is assumed from rainfall data (IFAD 1993), and while this conjecture is almost certainly correct, there are no empirical data being collected on the actual patterns occurring, on which to base management decisions.

89. Jordanian capabilities in rangeland research are very limited. NCARTT has one senior rangeland biologist of international experience (PhD from Utah State University, USA) and his associated technical staff. The Range Division of the Department of Forestry and Range also has a very limited personnel complement, consisting of three senior staff at Headquarters in Amman and a variety of technical staff in District offices, who are generally available, when

necessary, for forage assessment and management activities in their local Range Reserves. Most of the relevant staff in the Range Division are able to identify all plant species encountered in the rangelands. The Division has prepared a plant species list/dictionary for translation from Arabic to Latin nomenclature.

90. A programme for the Improvement of Agricultural Productivity in the Arid and Semi-Arid Regions of Jordan, performed jointly by the University of Jordan, NCARTT and a technical assistance team from Silsoe College, UK, has recently begun a four year programme of rangeland monitoring in the Steppe (University of Jordan, 1995). This programme would make estimates of rangeland composition and productivity at its study sites.

91. The Faculty of Agriculture, University of Jordan, has a small number of competent lecturers and research staff in the field of rangeland ecology and management, who have innovative ideas concerning the development of a rangeland management curriculum.

92. The Jordan Badia Research and Development Programme, under the Higher Council for Science and Technology, is, with technical assistance from Durham University, currently undertaking a series of studies, including interpretation of a variety of satellite imagery and the monitoring of vegetation and biodiversity, involving detailed studies of vegetation structure and dynamics, in their study area in the Badia of north-eastern Jordan.

SOILS AND LAND USE

93. The Department of Lands and Surveys maintains records of land registration and ownership which are available in summary form to government institutions. Detailed cadastral surveys are undertaken, but are confidential and have a strictly limited distribution.

Soils

94. A substantial dataset is held by the Soil and Land Use Division (SLUD) in the Ministry of Agriculture, covering soils and qualitative land cover information at reconnaissance level for the whole country. More detailed information is available only for the higher rainfall areas which are considered suitable for cropping.

95. Reconnaissance soil maps were prepared during the 'Level 1' survey, carried out between 1990 and 1995. (HTS & SSLRC, 1993). This involved some 42,000 sample sites covering the whole country (90,000 km^2) at a mapping scale of 1:250,000, with field observations at an overall density of one site per 7.6 km^2. LANDSAT multi-spectral imagery (April 1988/89), 1:60,000 and 1:100,000 scale aerial photography were used extensively during this work. Broad soil types were grouped into soil mapping units and depicted on 1:250,000 scale photographic maps produced from the LANDSAT imagery.

96. SLUD collaborates with RJGC for topographic mapping, aerial photography, satellite image processing, film writing and map production. Topographic maps are available at 1:250,000 scale and 1:50,000 scale. The 1:250,000 scale maps have been digitised, and digitising of the 1:50,000 scale maps is in progress. Aerial photographs are available at 1:50,000 scale for all of Jordan with larger scale coverage available for some areas.

97. During 'Level 1' studies the country was divided into 18 Land Regions, based on physiography (See Appendix 4, Map 7). Sample areas within each physiographic region were mapped at a semi-detailed level to examine geological, geomorphological and hydrological relationships affecting soils and land cover (See Appendix 4, Map 8).

98. Semi-detailed soil survey was carried out during 'Level 2' studies which covered 9,000 km^2 of land (See Appendix 4, Map 6). Priority in the selection of survey areas was accorded to land having potential for irrigated or rainfed crop production. Each zone extends into the steppe, which provides some of the best rangelands, and the Wadi Rajil descends from steppe into desert. Large areas of the steppe were, however, not included in this mapping.

99. Panchromatic SPOT imagery combined with LANDSAT thematic mapper was used at 1:50,000 scale and combined with field survey at an overall density of 3.5 observations per km^2 to map these areas. Soil, land suitability and land cover maps were prepared at 1:50,000 scale.

100. Detailed soil survey 'Level 3' was later carried in smaller parts of the 'Level 2' study areas on a 200m x 200m grid (i.e. 25 observations /km^2). 1:10,000 scale maps were prepared using panchromatic aerial photography at 1:25,000 scale. The report is in press, and contains information on soil physical properties. This information is important as it determines soil water availability and runoff quantities, which in turn influence the soil water balance. The information is only available in areas selected for semi-detailed and detailed soil survey, but many of the measurements were made in steppe areas and in Wadi Rajil.

101. Soil physical tests were carried out on the major Soil Series in each USDA Subgroup at representative pit sites that had been sampled for chemical analysis. Bulk density was generally low, ranging from: 1.29-1.39 g/cm^3 for clayey and fine particle size classes; 1.32-1.37 g/cm^3 for fine silty particle size classes; and 1.23-1.4 g/cm^3 4 for fine-loamy particle size classes. Average values were 1.34, 1.35 and 1.39 g/cm^3 respectively.

102. The available water holding capacity is influenced by mineralogy, montmorillonitic soils having higher available water capacities than soils with mixed mineralogy. Average basic infiltration rates were found to differ according to soil moisture regime. In areas with a xeric soil moisture regime rates ranged from 3-99 mm/h. Measured rates were lower in the transitional zone (5-40mm/h) and lowest in the aridic soil moisture regime (1mm/h). In Wadi Rajil rates ranged from 1-5mm/h. Low infiltration rates were found where ESP was above 4%.

Land Suitability Classification

103. The Soil and Land Use Project introduced the FAO Land Evaluation Procedure, in which land suitability is determined for specified Land Utilisation Types (LUTs). During the Project, land suitability was assessed for 5 precisely defined LUTs: rainfed, annual cropping; rainfed, perennial cropping; irrigated vegetables; rangeland; and forestry. The land suitability classes defined for different purposes were highly, moderately, marginally suitable and not suitable (S1, S2, S3, and N, respectively).

104. The rangeland LUT was defined as providing about 40 units per hectare (one unit being equivalent to 1 kilogram of barley), where rainfall is less than 100 mm, rising to 100 units per hectare where rainfall of 100-200 mm occurs. (Cropping of cereals and legumes is practised in the latter zone). In the highland areas there is a high proportion of planted species and crop residues are important.

105. Land suitability based on the criteria adopted for rainfed cropping and rangeland has been presented for each 'Level 2' study area. For each area, the proportion of land that should be used for cropping, rangeland or forestry is estimated.

Land Cover Mapping

106. The 1987 1:25000 scale topographic maps compiled from 1978-81 aerial photography show cultivated, orchard and forest areas and areas of grazing reserves. Soil surveys obtained land use descriptions and the floristic composition and ground cover at every soil observation point. Land cover was recorded in detail for all 'Level 2' study areas complemented by 1992 satellite imagery, and mapped onto topographic maps.

107. The mapping units included rainfed cropping (high, medium, low and very low intensity) rainfed and irrigated orchard crops, irrigated field crops, brush range (more than and less than 30% cover), grazing reserves and several categories of unvegetated and sparsely vegetated land (See Appendix 4, Map 9). Built up urban areas and other areas not available for agriculture have also been mapped.

Erosion and Land Degradation

108. Soil erosion is highlighted as one of the major factors in degradation of land resources in Jordan in the National Environment Strategy (IUCN, 1991). The main rainfed cropping areas, which are also important for grazing, are reported as being threatened by soil erosion and forest tree removal. Both steppe areas (land receiving 100-250 mm in an average year) and Desert areas (land receiving less than 100 mm in an average year) are reported to be subjected to erosion by water and wind, with sand dune formation and loss of rainwater through evaporation additional related problems in the drier areas.

109. Taimeh (1991) lists the factors thought to contribute to erosion, which include overgrazing, loss of vegetation, wind and flooding. However there has been very little quantitative measurement of erosion from either cropped land or rangeland in Jordan, though SLUD made qualitative observations during their surveys. Little evidence of accelerated erosion was recorded.

110. The edaphic characteristics of steppe lands may predispose them to erosion. The vegetative layer has been removed through overgrazing, currently estimated to have taken place in 30% of the steppe and more extensively in certain areas. It seems that in the desert areas, except in wadis and on some sand sheets, vegetation plays little role in soil stabilisation; a black gravel 'hammada' provides effective protection of the soil surface and this is disturbed only by mechanical means.

Cultivation and Land Use

111. Taimeh (1991) estimated that in Jordan only 3% of the country is suitable for rainfed cropping, 3% for perennial cropping and 3% is irrigable. He outlined a number of areas of concern relating to land use, including fragmentation of land holdings and loss of agricultural land and emphasised the importance of controlling erosion, conserving soil moisture and limiting the cultivation of steppe land.

112. The major irrigated crops in the Jordan Valley are vegetables, citrus and bananas. Wheat is sometimes grown under supplemental irrigation. In Disi/Mudawara wheat, forage and potatoes are grown under centre pivot irrigation, using groundwater. In other areas of the North limited water availability has led to salinity problems. Groundwater is also used in the steppe region, often for fruit. Horse shoe shaped earth dams on the north-eastern plateau and cisterns are the most usual water harvesting techniques used.

113. Land use is influenced by agroecological zone and irrigation water availability. Four broad land use types were recognised during SLUD's 'Level 1' studies: Rainfed cropland, Steppe, Desert and Jordan Valley.

114. The Rainfed cropping zone has a xeric moisture regime[3] and rainfall generally exceeds 250mm per year although significant production occurs where rainfall is between 200 and 250 mm on deeper soils in valley bottoms.

115. In the steppe, the deeper soils in valley bottoms have traditionally been used for barley and occasionally wheat. Rainfall is rarely adequate to produce a reasonable crop (500-1000kg/ha). The Rangeland Survey (HTS, 1956) reports that marginal lands were rarely ploughed before the advent of the tractor, but SLUD data suggests that since then cultivation has expanded dramatically, leading to soil loss and erosion.

116. In the Desert (Badia) Zone, wadis and valleys support a significant range of palatable species providing important grazing and browse in winter to early summer. In some wadis and depression margins, barley can be grown, and severe erosion of wadi silts may occur.

117. Although land use was not mapped during the national Soil Map and Land Use Project, the descriptions of the land cover mapping units for each Study Area given in the 'Level 2' report (HTS & SSLRC, 1994) give a great deal of semi-quantitative information about land use. The JOSCIS database also contains an agricultural land use intensity map derived from the 1991 FAO Plant Associations.

118. The Muwaqar project was established by University of Jordan in 1985 to assess the possibilities for improving production in the steppe belt by harvesting runoff, reducing erosion and improving soil fertility. The EC assisted with funding from 1985-89. A soil survey of the 200 hectare field site 40 km SE of Amman was carried out, a meteorological station was established and dams were built to control runoff. Experimental work was delayed due to late delivery of equipment, but observations on the regenerative capacity of unvegetated areas showed that 3-4 years of protection encouraged good recovery of natural vegetation cover without seeding.

119. The project is currently being extended, with further support from the EU, to cover off site studies in the Steppe and reach a wider range of potential beneficiaries. The new project "Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of Jordan" (University of Jordan, 1995) is a co-operative project between the University and the Ministry of Agriculture, with technical assistance from Silsoe College, Cranfield University, UK. SLUD intends collaborate through provision of expertise in soils and land use mapping.

120. The general approach of the project is to divide the 12,000 km^2 of Steppe into component catchments, which would be the basic land use planning units. The data base developed by SLUD will be used to provide soils, climate and land use information. Soil and water management practices involving water harvesting, supplemental irrigation, and rangeland improvement would be tested at a number of sites representing the whole area. Options based on appropriate water and land allocations will be worked out on a catchment basis for presentation to farmers.

[3]Soil partly moist for more than half the time that soil temperature at a depth of 50 cm is higher than 8^0 C

CLIMATE, RAINFALL AND HYDROLOGICAL DATA

121. The Ministry of Water and Irrigation has responsibility for all surface and groundwater resources, including water used for irrigation purposes. The Ministry has three Branches; (a) Jordan Valley Authority, which is responsible for irrigation and related services nation-wide; (b) Water Authority of Jordan (WAJ); and (c) The Ministry of Water and Irrigation. The latter is a policy and planning unit, concerned with initiatives establishing water resources assessment and monitoring functions, inter-sectoral activities and helps to support a Water and Environment Research and Study Centre.

122. Substantial water resources databases exist for Jordan. These include rainfall (See Appendix 4, Map 10), evaporation rates, base stream flow, flood flow, spring flow, ground water table levels, groundwater quality and groundwater abstraction. All this information is published at regular intervals (WAJ, 1987, 1992, 1994a,b,c).

123. Information on surface water resources of specific relevance to rangeland improvement is available for 15 surface management basins and 95 sub-basins. WAJ monitors baseflow and floodflow measurements from springs, streams and reservoirs and monitors groundwater levels and water quality. Despite the extent of the WAJ monitoring network, information for specific locations is generally very limited and few flow monitoring points are provided in the rangeland areas. The Water Resources Division at WAJ would be able to provide hydrological and groundwater data and assist in monitoring streamflow and runoff for water balance studies.

124. The USAID funded 'Water Quality Improvement and Conservation Project' is currently being implemented by the Ministry of Water and Irrigation, assisted by a team of consultants appointed by Development Alternatives Inc. Components of this project include improving the water resources data management system, the water resources and water quality monitoring system, the water quality testing service, pilot studies concerning artificial groundwater recharge, improving irrigation water use efficiency and delivery. The project is also working with the Jordan Environment Society to promote water conservation awareness.

125. WAJ is responsible for 292 rainfall stations, of which 95 are not working, and for 32 evaporation stations of which 11 are not working. Rainfall stations are present in all regions. Their data are phoned into the Meteorological Department daily. Since 1990, the daily data have been entered on CLICOM (a World Meteorological Organisation (WMO) database) and information from 1988 is available in this format. Rain gauges are fitted with chart recorders. The information required for calculating rainfall intensity is therefore available for analysis.

126. The Meteorological Department of the Ministry of Transport maintains 35 meteorological stations throughout Jordan. Relatively few of these stations are in rangeland areas. Seven are maintained specifically to serve agricultural needs.

127. The Jordan Climatological data handbook (Meteorological Department, 1988) provides geo-referenced mean monthly data calculated over 10-30 years for 32 meteorological stations, this includes:

- Air temperature
- Soil temperature
- Rainfall
- Relative humidity (06.00, 12.00,18.00 hrs)
- Wind speed and wind run (19 stations)
- Vapour pressure
- Sunshine (21 stations)
- Solar radiation (9 stations)
- Class A pan evaporation
- Potential evapotranspiration (7 stations)

128. The Department's Agro-meteorological Division produces an Agro-meteorological Bulletin, giving 10 day means of soil temperatures to 100 cm depth, Class A pan and potential evapotranspiration calculated by the 1977 FAO modified Penman Method (without correction factor). Calculations showed slight underestimates when compared with lysimeter data measured in 1970-72. A simple water budget is used to provide dekadal calculated soil water balance. The requisite expertise is available to provide climatic data, install meteorological equipment, calculate rainfall erosivity and carry out statistical analysis of data for analysing the influence of variation in climatic conditions that might mask long term land degradation.

129. The Department's METEOSAT satellite system produces images of cloud cover and temperature on a daily basis for the whole of Jordan which may be used to estimate the daily probability of rainfall at an 8km resolution.

SOCIO-ECONOMIC INFORMATION

130. A rapid rural appraisal and baseline socio-economic survey of the Jordanian rangelands (Badia) and adjacent regions was undertaken in early 1995 by the Ministry of Agriculture and the Queen Alia Fund (Blench, 1995a,b). The main findings of the survey, which included some 664 households and 85 communities, are summarised below.

131. There has been a major breakdown in 'traditional' migration patterns in favour of the opportunistic search for pasture. This is associated with an analogous breakdown in land tenure systems in the rangelands. In practice almost any rangeland is available to those who can exploit it.

132. The monetarisation of sheep production is leading to stratification of flock ownership. Owners of larger flocks (>1000) can take advantage of the economies of scale (shepherding, investment in vehicles, veterinary call out costs etc.) and likely to survive the removal of feed subsidies. Owners of medium sized flocks cannot take advantage of these and do not have the resources to manage their herds without getting into debt.

133. Owners of very large flocks in the Badia regions have essentially switched from using the rangeland as a source of feed to simply treating it as physical space to raise animals. Most livestock owners make use natural rangeland vegetation for only a few months a year and truck in feeds for the rest. This means that the *economic motivation* to conserve the rangelands is minimal.

134. The survey also suggested that producers do not generally feel *responsible* for the condition of the range. Its problems are largely attributed to poor rainfall or encroachment of agriculture. This is an important observation, the implication being that, if livestock owners do not perceive a linkage between livestock numbers and range condition, they are unlikely to respond favourably to exhortations for radical stock reduction.

135. An alternative scenario, more in line with current practice, would be to encourage herd owners to switch to year-round feeding; a feedlot system in all but name. This would have to go hand in hand with a major change in ruminant nutrition to compensate for the loss of roughage and minerals represented by range.

PUBLIC AWARENESS AND NETWORKING

136. Aside from the occasional interest expressed by the Press and the activities of the Royal Society for the Conservation of Nature, there are relatively few mechanisms for promoting concern for the environment and sustainable development in Jordan. One of RSCN's primary goals is to raise awareness of the importance of Jordan's natural resources and enhance public and political commitment to their conservation and sustainable use. The Society receives support from the Global Environment Facility and has recently established a Public Awareness Section to mount campaigns for protection of the environment and conservation of nature.

137. With co-operation of the Ministry of Education, messages are targeted at some 400 nature conservation clubs at schools across the country, and a range of posters, pamphlets and education materials has been prepared. A series of short films, radio programs, TV spots, media workshops and seminars are planned. The Society also publishes a quarterly magazine "Al-Reem" as part its public awareness campaign.

138. Various institutions have established development networks that have regular contact with rural populations as a result of their on-going activities. These include the Queen Alia Fund (QAF), which has set up over 50 rural centres, designed to promote various small scale enterprises and provide technical advice to beneficiaries on agricultural an other issues. Many of their activities are carried out by volunteers, which now number more than 25,000 nation-wide.

139. The Jordan Co-Operative Organisation is also in contact with many of rural inhabitants, particularly in the more densely inhabited regions of the country, through its established co-operatives. These include a number of livestock co-operatives and communally managed grazing reserves around the country. However, due to the recent collapse of the Co-Operative Bank, JCO's future is uncertain. A World Bank Mission is scheduled to identify re-structuring requirements in the near future.

140. The Ministry of Agriculture's Extension Department has regional officers who are charged with communicating extension messages, largely concerned with crop production, to farmers. In theory, this mechanism could be adapted to reach pastoralists, but the network is in its infancy, and currently reaches only a small fraction of the population.

141. A variety of potential network components are therefore already in place that could be used to reach pastoralists in the more accessible areas in the western half of the country. There are, however, few that extend to stock holders in eastern and southern regions.

LIVESTOCK

142. A considerable amount of information on livestock is available, primarily from the Department of Statistics (DoS), which conducted a Census in 1991, followed up by bi-annual sample surveys in April and October each year. The Census methodology was based on village owner enumeration, whereby, on October 1st, all livestock owners were required to report to one of 1,200 counting centres across the country, and have their flocks counted by DoS enumerators.

143. The sample surveys covered some 3,000 owners, selected according "Probability Proportional to Size" (PPS) criteria. The numbers claimed by each owner are compared with records for the same individual from the previous enumeration, and a trend established which is then applied on a country wide basis.

144. The other major source of primary livestock data is the Veterinary Department of the MoA, which conducts extensive monitoring of animal health and selected productivity and management related parameters. Substantial numbers of animals are routinely assessed - their 1994 report states that, during that year, 6,500 flocks comprising 683,000 animals, were visited.

145. Population levels of horses, donkeys and camels are very low. Relatively few cattle are kept and are reared, almost exclusively, under conditions of intensive management. The combined impact of these species on Jordanian rangelands is minimal, compared with that of sheep and goats, so further discussion concentrates on small ruminants.

Numbers

146. Despite the detail they contain, the DoS figures are often disputed, largely because they differ significantly from Ministry of Agriculture estimates derived from vaccination records. Part of the difference comes from a degree of apparent confusion on the part of MoA as to which figures refer to which years, possibly as a consequence of clerical error rather than any real difference in interpretation. However, there is also some disagreement as to the validity of a marked rise in animal numbers indicated by 1991 DoS Livestock Census, which could well be the result of a change in methodology rather than a real change in numbers.

147. There is some scepticism about the 1991 census methodology. The main reason being that numbers were derived from the holdings of owners reporting to counting centres, where certificates were issued which determined the allocation of subsidised feed inputs. Though a number of precautionary measures were taken, the incentive for inflating individual holdings undoubtedly remained. Conversely, livestock numbers could have been underestimated in some of the remoter areas of the country, where herd owners might have been unable to present their stock, or unwilling to declare the presence of illegally imported animals.

148. Owners questioned during sample surveys are not given subsidised feed certificates, thus removing a possible incentive to inflate figures, which might account for the drop in published livestock populations recorded since 1991 (See Appendix 4, Map 11). However, if the decline in livestock numbers is real this would imply that there has been substantial destocking over the past few years - possibly in response to the reduction in feed subsidies that has taken place, in line with the Structural Adjustment Programme and preconditions of the proposed Programme for Range Rehabilitation and Development.

149. It should, however, be pointed out that reliable livestock data are notoriously difficult to collect using ground based techniques, even if there is a 'universal' registry of the type common in, for example, the European Union. DoS staff are statistically skilled and have access to substantial and complex data processing equipment, which is also used to process and store the human population census records, as well as detailed statistics on livestock and crop production.

Distributions

150. Even if the livestock population figures are accurate, the published data cannot be used to establish livestock distributions on any but the scale of the Governorate (See Appendix 4, Map 11). This could undoubtedly be overcome by using smaller map units - in theory, the data are available for each named owner, at each village counting centre. However, the Department is reluctant to provide the figures at this level in case respondent confidentiality is compromised.

151. Further, even if the data were released, DoS have not geo-referenced the counting centre locations, so village level figures could only be produced if efforts were made to identify and attach geographical co-ordinates to the existing records.

152. Animal numbers for the Census counting centres cannot, however, be used to assess detailed animal distributions. Nor can the sample data for 1992-1994 be interrogated to provide reliable comparative distribution data. This is because the 'catchment' area of each counting centre cannot be precisely defined, nor can the animals be accurately located within each 'catchment'. Such problems are obviously more relevant in remoter areas, where counting centres were more widely dispersed.

153. As a result, it is currently impossible to relate livestock distribution to the presence of rangeland, or cropping, and so the degree of grazing resource utilisation cannot be ascertained. It is also not possible to assess changes in distributions at any satisfactory level. Thus, animal movements cannot be related to changes in rangeland condition, the duration of grazing, or, indeed, to variations in cropping patterns. This precludes any analysis of either livestock movement, or its distribution relative to rangeland or crop resources. Such analysis is essential if the pressure on natural grazing or extensively planted farmland is to be assessed effectively.

Herd Productivity

154. The available DoS data on livestock also include a substantial tranche of herd productivity information. Some of these data are independently assessed by the Veterinary Department, who informed the Mission that their findings generally corroborate those of the DoS.

155. Given that such information is usually collected by inspection and by interview of a representative sample of animal herds, and given that DoS Census and Sample Surveys involve a minimum of 3,000 respondents, it seems probable that the official productivity figures are reliable. It is difficult to envisage any incentive to falsify these data, and so the statistics available for these parameters are probably adequate for most purposes, and additional data collection would not be required to provide reliable national statistics.

156. That said, a comparison of the published results from the 1991 DoS Census, the 1993 DoS Sample Survey, and the 1994 Veterinary Department figures do reveal some rather startling contrasts. For example, the proportion of both sheep and goats over a year old appears to have increased by a factor of four in the two years between the DoS surveys. If the population figures are reliable, this change is due to a substantial reduction in the numbers of young-stock, alongside a marked rise in the numbers of older animals. However, a definitive interpretation of such data relies on accurate population assessments, which may, as repeatedly pointed out in these paragraphs, not be available. The Veterinary Department age structure data for 1994 appear to continue this trend, but, in the absence of longitudinal herd monitoring data and geographical referencing, it is difficult to draw firm conclusions.

157. Fertility data are collected by the Veterinary Department, and assembled in an annual report. An outstanding feature of these figures is the extremely low twinning rates recorded for both species. They are, however, corroborated, in general terms, by other sources (e.g. the JCO, BRDP - see section on Health, below), which suggests that the figures are accurate enough to provide a national overview. Some of these figures can be compared with data produced for 1993 by DoS. Given the possible sources of variability, these two sets of data are sufficiently close to suggest that both are reliable at the national level.

Production and Economic Data

158. The bi-annual DoS Sample Surveys produce an abundance of information relating to inputs and outputs. These include: capital formation and fixed assets, farm-gate prices and costs, import and export levels for both animals and feed, as well as the input/output information required to estimate value added during each year. These can be used to extract wide range of information - e.g. terms of trade, production levels of imported and local livestock, and so on. The information certainly appears to form a comprehensive base for most planning purposes at a national level - assuming that the population levels used as multipliers for the summary tables are accurate - though there is little in the way of regional breakdown.

159. There are, however, a number of inadequacies in the current knowledge base these data represent. Little information is available on livestock marketing at the household level particularly concerning the reasons for livestock sales - whether they are production or market led - and the relative importance of livestock within the household economy is a topic about which the Mission was unable to find any concrete assessments.

160. Similarly, the number of animals maintained under intensive feedlot management is poorly documented. If, as considered in the Formulation Report, intensification and feed-lotting is seen as a mechanism for destocking, reliable information would be needed on baseline levels of production, which would have to be carefully monitored during the course of the Development Programme.

Health

161. The Epidemiology and Production Monitoring Division at the Veterinary Department conducts widespread monitoring programmes, but is hampered by insufficient data processors, and outdated software. Thus, despite more than adequate technical skills, substantial amounts of data have been collected, but neither processed or analysed because of a bottleneck that would require relatively few additional resources to alleviate. Additional monitoring on a limited scale (20 herds) is carried out by the Jordan Co-Operative Organisation and BRDP at the Safawi Field Centre.

162. The Department's figures for disease incidence in 1991/2 suggest, among other things, that the incidence of infectious diseases is low. Despite the scale of the surveys used to collect the information, these statistics are, however, disputed in some quarters. For example, some institutes (e.g. JCO) hold that animal health is a major problem throughout the country - particularly, Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD) and Blue Tongue in sheep. The Veterinary Department, in contrast, maintains that Blue Tongue and PPR are rare in most parts of the country and are only problematic under feedlot conditions, where animals from different herds are concentrated at fixed locations for extended periods, thus facilitating transmission of disease from infected animals.

163. A major reason for this disagreement is the widespread prevalence of sub-clinical symptoms, particularly of PPR and Blue Tongue in sheep, which are not generally diagnosed by the Veterinary Department surveys of clinical incidence. However, Veterinary Department serological samples indicate a 20 -30% sero-positive level, indicating the validity of this criticism. This situation is further complicated by the concurrent sub-clinical presence in many flocks of PPR, Blue Tongue and Foot and Mouth Disease.

164. With the intensification of livestock production envisaged for the years to come and the continued expansion of feed lotting, it is clear that disease control will become an increasingly important aspect of efficient and competitive forms of animal husbandry.

165. Overall mortality data are produced by both the Veterinary Department and DoS. Unfortunately the two data sets are not directly comparable as the former are concerned with deaths caused by clinically diagnosed diseases, whilst the latter refer to all sources of mortality. Provided these restrictions are appreciated, there is no reason to suppose that there are any serious inaccuracies in them. Again, however, the lack of small scale regional information in the published reports restricts the potential uses to which the data can be put.

Livestock Management

166. The recent socio-economic studies have provided an overview of livestock management practices. They have, however, generally been rapid assessments, rather than detailed or long term studies. In particular, the ownership patterns of livestock that utilise the natural rangelands are little understood, as are the perceived constraints affecting livestock production in the more remote regions, in particular the interaction between resident and immigrant stock owners. These factors need to be better appreciated before any substantial rangeland rehabilitation is attempted.

III. THE PROJECT - RATIONALE, OBJECTIVES AND DESIGN

167. This Section outlines the basic rationale, objectives, and design of a proposed project which aims to provide a knowledge base that can be used to plan interventions suitable for long term rangeland rehabilitation in Jordan. The Section also summarises proposed activities and duration, outlines the costs envisaged and considers the likely environmental impact. Details of project content and activities, possible schedules, and implementation issues and risks can be found in succeeding Sections.

PROJECT RATIONALE

168. The previous Section demonstrates a wealth of data and skills available in Jordan, so much of the information and expertise required for an effective assessment of pastoral resources is already accessible. It is, however, dispersed amongst a wide range of government and other institutions, and there is currently little co-ordination, or exchange of information between the various organisations.

169. There are also several notable deficiencies in current knowledge and perceptions. Two of the major lacunae concern the verification of the current ecological state of the rangelands and their potential for utilisation by livestock, as shown by their distribution in relation to the prevailing grazing, edaphic and climatic conditions. These are topics best addressed by some form of remote sensing, together with ground truthing exercises.

170. The economic and socio-economic patterns, incentives and motives for livestock keeping also need to be clarified, despite the recent surveys undertaken by IFAD. In this vein, the very subject of 'state of the rangelands' needs to be added to the public and political agenda before any major interventions are planned.

171. A number of other subjects need to be investigated or confirmed - particularly the livestock population levels and the degree to which current utilisation is related to rangeland condition, as well as certain issues concerning animal health in relation to intensification.

172. It is therefore proposed that a special Unit be established for Pastoral Resource Information, Monitoring and Evaluation (PRIME). The Unit would be responsible for collecting, collating, and integrating all information relating to rangelands, livestock, and land-use currently available in Jordan. This would be undertaken through formal collaborative agreements within government and other institutions.

173. Where necessary, ancillary studies would be commissioned to fill information gaps, and obtain additional information, as required. Supervision, equipment and training would be provided, where needed. In order to minimise start-up costs, such studies would be achieved through building on planned or existing projects, where practical, and by strengthening or expanding existing national capabilities.

174. The success of this strategy would very much depend on effective collaboration between the proposed Unit and the institutions and agencies with data currently available, and with those commissioned to carry out additional studies. One of the Unit's most important initial tasks would therefore be to establish links with relevant institutions. These would include a number of government Departments as well as non-governmental institutions. All those approached during the course of the Mission indicated their willingness to co-operate, and a number offered assistance, either by making facilities and logistic support available at no cost,

or on a cost recovery basis (see also paragraphs below). It is recommended, however, that full implementation of the Unit be made conditional upon the establishment of formal agreements for collaborative study and the exchange data.

175. All collaborating bodies would be strongly encouraged to participate in the analytical and interpretative stages of this process and would be given access to the results. Planners and decision makers would also be kept closely informed of the Unit's work.

PROJECT OBJECTIVES

176. The initial objective of the proposed Project would be to carry out an assessment of pastoral resources in Jordan within a comparatively short time-frame. This would establish a baseline describing the current state of rangelands and rangeland resource use from a national perspective. An assessment of long term trends would also be undertaken.

177. Information obtained would be analysed and interpreted at a technical level to identify specific areas best suited to the interventions proposed for the Development Programme, as well as to assist those planned by other institutions and projects. The initial assessment would be followed by monitoring activities to update the baseline data and thereby establish trends in monitored parameters, provide more detailed assessments where required, and to concentrate on specific areas related to ongoing or planned implementation and research activities.

178. An intermediate goal of the proposed Project would be to provide planners, both in Government and in the private sector, with the reliable and objective information, interpretation, and perspective required to identify appropriate development strategies for the long term sustainable utilisation of Jordan's rangelands. Once the requisite data are assembled, the Unit's primary function would be to analyse and interpret the material obtained and to make both the processed data and the results of the analyses available to collaborating institutions, and to the National Information System, as required.

179. High resolution maps identifying appropriate areas for cropping, natural grazing, would be compiled by integrating the rangeland distribution, land suitability, and range production data. Degradation risk maps would be produced by analysing land suitability and rangeland resources data in relation to cropping and livestock levels. Sites appropriate for possible rehabilitation or intervention would be identified using both the appropriate land use assessments and the degradation risk maps.

180. A central tenet of the proposed Development Programme is the reduction of grazing pressure on the threatened rangelands, through some form of destocking. This is unlikely to be popular with pastoralists given their present perceptions and constraints, and can only be achieved if pastoralists themselves see the long term benefits of sustainable rangeland use, and if there are appropriate incentives to modify present livestock management strategies. A dialogue should therefore be established between planners, implementers and pastoralists, designed to inform livestock owners and respond to their opinions.

181. As pastoralists in Jordan constitute a diverse socio-economic group, an extensive information campaign would be mounted and directed at the general public, as well as the traditional pastoralist producers. This would be designed to raise environmental awareness, and to elucidate the complexity and potentials of pastoral rangeland management. Participation in decision making would be actively encouraged through feedback to planners.

182. The Project would establish a national pastoral resource assessment and monitoring capability which, in the medium term, would be self-sufficient in technical expertise.

PROJECT DESIGN, ORGANISATION AND MANAGEMENT

183. Essentially, the Project would consist of a core management, information processing and policy advisory unit, with a series of specialist working groups attached to it. The unit would have overall responsibility for initiation, supervision and co-ordination of a range of complementary studies, some of which would be conducted "in house", whilst others would be contracted out to collaborating institutions, or performed on a consultancy basis.

184. In view of the likely future re-organisation of the Ministry of Agriculture, it is only possible to provide outline specifications for PRIME's institutional framework and organisation. The following paragraphs therefore provide an outline structure which can be finalised by GoJ in conjunction with the proposed Project's funding bodies, once any re-organisation has been implemented. This process is seen as the first step of Project Implementation (see also Section V).

185. The Unit would be physically located within the Ministry of Agriculture's Department of Forestry and Range, and could be attached to the Range, and Soils and Land Use Divisions of that Department. However, because of its interdisciplinary interests and activities, the Unit would require a substantial degree of administrative autonomy, as well a sufficient authority to deal with other Ministries and NGOs. Thus, it may be more desirable for the project manager to report directly to high level Ministry bodies such as the Agricultural Council, or the Secretary General's office.

186. Given the wide-ranging co-ordinating role of the proposed Project, and the need for establishment of an extensive network of contacts, both within and outside Government, it is envisaged that the Project would also require the authority of an influential steering committee representing the main collaborating institutions. These might include representatives of: the Ministry of Agriculture; Department of Lands and Survey; Jordanian Co-Operative Organisation; Department of Statistics, Ministry of Planning; Meteorological Department; Higher Council for Science and Technology; Royal Jordanian Geographic Centre; Queen Alia Fund; and University of Jordan's Faculty of Agriculture. The composition of the proposed committee should reflect not only the degree of collaboration with PRIME, but also should be evenly balanced between Government and Non-Governmental bodies so that 'passive resistance' in any particular quarter can be out-voted and thus disarmed.

187. In order to ensure the smooth execution of the proposed Project, particularly the identification and commissioning of the necessary studies, the unit would require substantial financial autonomy. This may include the payment of non-standard salaries and expenses to PRIME staff in order to ensure their whole hearted involvement with the Project.

188. A detailed work programme would be prepared each year, which would set specific targets to be achieved within defined time periods. Studies undertaken on behalf of the project by collaborating organisations would be subject to contractual agreements specifying respective inputs, anticipated outputs and time-frames.

189. An annual project report would be prepared and circulated amongst collaborating organisations and other interested parties. This report would include a section providing a general overview of the status of range and pastoral resources. In due course, it is envisaged

that this section could be expanded and published separately as an annual 'State of the Rangelands' report.

190. Modalities for the utilisation of project outputs would be through direct and indirect influence on formulation and implementation of agricultural and environmental policy, relating to the sustainable development of dryland areas. Direct influence on policy issues would be via reports and recommendations targeted at advisers, policy makers and decision takers in Government, particularly the Department of Policy and Agricultural Economics, the Agricultural Council, the Secretary General, the Minister and Cabinet. Direct influence on implementation would come with the formal establishment of the Programme for Rangeland Rehabilitation and Development. The cadre of trained and experienced pastoral resource assessment and range management personnel would also be substantially increased.

191. Indirect influence would be achieved through various means, including media coverage and heightened awareness of the general status of Jordanian rangelands, both within Government and amongst the public at large. A network of communications with pastoralist and rural communities would be fostered through NGOs, traditional leaders and other semi-official and official channels, to sound out opinion on complex issues involved in pastoral resource management and obtain feedback on options available for future development.

192. Project activities would all contribute to a better understanding of pastoral resource dynamics, through establishment of a pastoral resource monitoring system. However, for the sake of convenience, special studies have been divided into a series of Sub-components, the salient features of which are summarised in the following sections. Further information, including: detailed technical justification, terms of reference, job descriptions, collaborative links and itemised cost estimates are to be found in the Annexes.

Box: Summary of PRIME Resource Assessment Activities

- *Range Assessment and Monitoring Studies* through which the requisite data concerning rangeland distribution, seasonal availability, production and quality would be brought together. Past and current trends in rangeland extent would also be assessed. Much of these data would be acquired by remote sensing techniques, which need extensive ground truthing to validate and interpret reliably. Models of forage biomass production would be developed and refined, and pilot studies would be set up to experimentally assess long term benchmark data on sustainable grazing levels;
- *Soils, Water and Land Use Evaluation and Mapping Studies* which would primarily investigate the suitability of land for rangeland or cropland use, and its potential for forage production. This would be done by monitoring soil water balance and erosion effects; identifying and assessing cultivation levels, trends and distributions; assessing the effects of cultivation on rangeland production potential; and detailed soil mapping.
- *Livestock Related Studies* designed to establish levels and patterns of resource utilisation by livestock, verify existing livestock population data, and establish the true state of animal health in the country. This would be accomplished by assessing animal numbers in relation to the distribution of rangeland vegetation and cropland at different times of year, and by strengthening of several existing institutions. Various socio-economic aspects of livestock management in remote areas would also be assessed.
- *Institutional Support and Collaboration* providing training and equipment to collaborating organisations.

PROJECT COST AND DURATION

193. The Project Baseline Cost, at 1995 prices, is estimated at US$5.340 million (JD3.686 million). With the addition of physical and price contingencies, this increases the total estimated cost for the proposed Project to US$6.17 million (JD4.259). Of this amount, US$3.65 million, or about 59%, would be foreign costs. Summary project costs are set out in Tables M2.1 to M2.6 in Appendix 2, and are summarised in the table below. Detailed project costs are set out in Tables A5.3 to A5.12 in Annex 5.

Table 1: Project Cost Summary

Components	US$ Million Local	Foreign	Total	% Foreign Exchange	% Total Base Cost
1. Pastoral Resources Information Monitoring & Evaluation Unit (PRIME)	1.337	2.025	3.362	60	63
2. Range Assessment and Monitoring	.284	.300	.584	51	11
3. Soil & Land Use Evaluation & Mapping	.145	.375	.520	72	10
4. Livestock Related Studies	.251	.404	.655	62	12
5. Institutional Support & Collaboration	.144	.076	.220	35	4
Total Baseline Costs	**2.160**	**3.180**	**5.340**	**60**	**100**
Physical Contingencies	.079	.090	.169	53	3
Price contingencies	.283	.378	.661	57	12
Total Project Costs	**2.522**	**3.648**	**6.170**	**59**	**116**

194. It is assumed that office accommodation for the unit would be provided by Government and since this is a non-incremental cost, it has not been included within the cost estimates. Several of the activities proposed would be premised on the provision of existing facilities and space, or collaboration on a cost recovery basis, by a number of government and non-government organisations. These have not therefore been incorporated into the Project costs, but represent a substantial contribution in existing facilities, overheads and in kind.

195. The proposed Project would run for a period of 5 years, which is considered the optimum time necessary for establishing reliable data on national trends in rangeland use and status. An alternative would be to consider funding the project over a three year period, with the costs for PY4 and PY5 being incorporated into the National Programme for Range Rehabilitation and Development. Total project cost for the three year period would amount to US$ 4.98 million (JD 3.47 million).

196. Should the proposed Development Programme not materialise, this alternative would mean that PRIME would be guaranteed a life of only three years. Whilst this would be sufficient to ensure the accomplishment of the Unit's primary aims - the provision of an adequate pastoral resource assessment; to establish trends in rangeland cover; and to identify the areas of rangeland most suited to intervention - it is the minimum period required, and may compromise the Project's longer term objectives. In particular, the training and technology transfer elements may be less effective within a three year time frame, as these processes require substantial training, followed by the accumulation of substantial experience.

197. A three year Project would also reduce the effectiveness of the awareness building programme, given that it would not start in earnest until the resource assessment stage was well in hand. The sectors of the population most affected would be those most difficult to reach and influence because it would take longer to set up and implement effective mechanisms of communication with them. These would most probably be the inhabitants of remote areas and those, such as civil servants, with vested interests in the *status quo*.

198. A number of the proposed studies would also be either lost to the Project (such as the Regulated Grazing Studies) or curtailed, thus reducing their value - especially those involving long-term monitoring or manipulation. These long-term studies, though fairly low-cost, are the ones which would allow the primary interpretations and recommendations to be fine-tuned to the level of local rather than regional or national application, and thus permit the more accurate targeting of resources to those localities or populations in most need.

199. Although the Project is defined in the Formulation Report as a precondition to the Development Programme, it is recommended that the Programme be scheduled to commence towards the end of the resource assessment phase (18 months after start-up), rather than at the end of PRIME's projected life. This would allow closer interaction between PRIME and Programme staff, and ensure more efficient identification and targeting of Programme interventions, as well as more responsive analyses and interpretation by PRIME's personnel.

Procurement

200. Procurement procedures would be governed by the "Guidelines for Procurement under Financial Assistance from IFAD", the details of which would be submitted to Government after the signing of the Loan Agreement.

201. Before beginning procurement, GoJ would furnish to IFAD for approval a list of goods and services to be procured as well as the proposed grouping of goods in order to permit optimum use of competitive bidding.

202. Standard guidelines for the procurement of goods are as follows:

- US$ 20,000 or less - local shopping procedures, acceptable to IFAD, after solicitation of quotations from at least three suppliers.
- US$ 20,000 to US$ 50,000 - Local competitive bidding procedures satisfactory to IFAD; confirmed copies of such contracts, together with analysis of the bids and recommendation of the award would be sent to IFAD, before submission of withdrawal applications.
- US$ 50,000 to US$ 100,000 - International shopping procedures acceptable to IFAD, after solicitation of quotations from at least three suppliers.
- US$ 100,000 and above - International competitive bidding procedures, satisfactory to IFAD, confirmed copies of such contracts, together with the analysis of the bids and recommendations of the award, would be sent to IFAD before submission of withdrawal applications.

203. Contracts for the provision of consultancy services, whether local or international, should also be in accordance with the IFAD guidelines.

ENVIRONMENTAL IMPACT

204. This project would be the resource assessment and monitoring component of a proposed Programme for Range Rehabilitation and Development. As such, it would have no immediate, direct impact on the environment, although it is specifically designed to strengthen institutional capacity. The project would also raise awareness of the complex issues involved in range resource management, at all levels of society, including pastoralists, policy makers and the general public.

205. By so doing, the proposed project is intended to have a long term beneficial impact on the environment. The wider appreciation and better understanding achieved by this project would also assist the detailed design and targeting of the proposed Programme for Range Rehabilitation and Development, and contribute to more the effective use of resources.

IV. PROJECT CONTENT

PROJECT SUB-COMPONENTS

Pastoral Resources Information Monitoring and Evaluation Unit (PRIME)

206. In the first instance, PRIME's roles would be to: provide a national focal point for range resource assessment; facilitate the collection of reliable and up to date information; standardise procedures for processing, analysis and storage of data; and establish a sound baseline for long term monitoring and policy analysis.

207. Once properly established, PRIME would then be in a position to take on additional responsibilities, including the targeting of potential interventions for the Programme for Range Rehabilitation and Development, and the identification of alternative options. Close co-operation with implementing agencies and collaborating institutions would be required to: ensure that database structure was suitable for analyses; prioritise interpretative procedures to meet implementation needs; and provide appropriate products in a timely and efficient manner.

208. Whilst PRIME would act as the central focal point for range resource assessment, it would rely largely on external organisations for the gathering of additional information. These studies would be commissioned either according to terms of reference proposed by the present Mission (see Annexes), or as in due course determined by PRIME itself. Strict guarantees of performance would be defined in the terms and conditions of these sub-contracted studies.

209. The Unit would be responsible for ensuring provision of adequate technical assistance as and when required, either from its own resources, or by identifying and recruiting suitable short to medium term assistance from within, or outside Jordan. The Unit would also be responsible for the provision of some logistic support by, for example, assigning vehicles from its own pool for short-term field work, and for providing specialised equipment where required.

210. It is envisaged that the Unit would have assembled sufficient information to be able to produce useful output within 18 months of start-up. During this initial period, the Unit would have carried out a baseline pastoral resource assessment from a national perspective, which would subsequently be updated on a regular, but less intensive basis.

211. Once the initial pastoral resource assessment had been achieved, PRIME's subsequent activities would be directed at: refining the primary database; building national capacity to ensure sustainability of the Unit; and conducting more detailed studies associated with specific local interventions.

212. PRIME would also commission a series of socio-economic surveys to be implemented by collaborating institutions and consultants, and oversee the collation and analysis of information obtained from such studies. The objective of these activities would be to identify those elements of the rural population most susceptible to the impact of rangeland degradation; defining their geographical locations; and thus providing an objective basis for targeting inputs and activities for poverty alleviation.

213. Awareness building and the promotion of pastoral participation is considered to be one of the key functions of the Unit. To this end, PRIME would design and supervise implementation of a national awareness programme to: raise the profile of rangelands and arid land development, both amongst pastoralists, themselves, and the wider general public; identify

and focus in on the problems that need to be addressed; and highlight the consequences of neglect and misuse.

214. The Unit would establish appropriate mechanisms for informing public opinion, and creating an effective dialogue with pastoralists in urban, peri-urban and rural areas, including use of national media, network newsletters, discussion fora and audio-visual presentations. In addition, existing dissemination networks would be used wherever possible.

215. The results of technical analysis and interpretation are, however, rarely suited to public consumption, and need to be adapted and translated into a more digestible form if they are to be disseminated outside technical circles. PRIME would, therefore, be required to produce material in a form suitable for mass circulation to the population at large, as well as pastoralists and their representatives, and other organisations with established links to target populations. This would involve close collaboration with the media and other dissemination networks.

A). Staffing and Equipment

216. The PRIME co-ordination unit would operate as a compact, tight-knit group of high grade well motivated staff, headed by a Senior Jordanian Project Manager, supported by Technical Assistance staff and short-term, back-up consultants, of both national and international origin.

217. Specifically, there would be a Project Manager (PM), with a doctorate or equivalent postgraduate qualification and at least 15 years experience in the field of agricultural development or environmental management. The PM would initially be responsible for setting up the Unit, and thereafter for its overall performance and smooth operation, and ensuring the successful co-operation of the collaborating institutions. The PM would also be the de-facto administrator of the Project.

218. In addition there would be three M.Sc. grade and two B.Sc. grade local staff:

- Socio-economist, whose primary role would be the co-ordination and implementation of the awareness programmes and socio-economic surveys;
- Senior Monitoring and Evaluation (M&E) Officer, who would be responsible for the more technical aspects of data collation and analysis, and who would ensure the statistical validity of the field data collection programmes, and the compatibility of the various data types obtained;
- Range Management Officer, with responsibility for organising and supervising the collection of field data defined in the Range and Soils Study Sub-Components; and
- two Junior Monitoring and Evaluation Officers, assigned to assist the Senior M&E Specialist in computer operation and processing of field data. These Officers may also be seconded to collaborators for short periods to assist with preliminary data processing.

219. Before their appointment, it should be made clear to all senior staff that, subject to the provision of suitable allowances, they should be prepared to make extended visits to the field, and should not expect to spend the majority of their time in the Amman office. This should be stipulated in their employment contracts. Salary and allowance levels may well have to be

enhanced in order to provide realistic and effective inducements, and ensure adequate motivation.

220. It is envisaged that there would be four Diploma standard Computer Operators, who would process incoming field data forms, and carry out the primary data entry procedures. These personnel should have at least two years experience of computer data processing, and be sufficiently familiar with agricultural or environmental information to be able to screen incoming data for obvious errors and omissions. Their day to day activities would be organised and supervised by the senior staff.

221. Other supporting staff would include a secretary to assist with administrative paperwork, and drivers.

222. Technical Assistance would be provided in the form of two full time professional officers - an environmental specialist to work with the Range Management Officer, and an information/image processing specialist to work alongside the Senior Monitoring and Evaluation Officer. Each would be responsible for identifying the initial guidelines and subsequent work programmes for their counterparts, and for providing 'on the job training' to ensure continuity of project activities after their departure.

223. PRIME's analysis and interpretation must be placed in an appropriate economic context. A consultant environmental economist would, therefore, be retained to review PRIME's work plans and findings, on a twice yearly basis; advise on economic and socio-economic considerations; and strengthen arguments for sustainable use of range resources.

224. Significant levels short-term technical assistance would also be required, both to provide specialist training in the use of GIS and remote sensing software to PRIME staff, and some of the collaborating institutions, particularly in the initial phases of the Project. Training in these areas is available from RJGC, and so could be provided locally.

225. In addition to PC facilities, the Unit would require A3 digitising, colour scanning and A3 colour printing capability, for the production of maps and publicity material for use in the awareness campaigns. Adequate tape and optical disk drive data backup and storage would also be required

226. PRIME would require the ample processing capability that is currently available only from UNIX workstations. These would be provided for both the Range Management and M&E staff, along with ancillary hard disks, and backup devices. The workstations would be equipped with the high specification GIS and image processing software required for compatibility with RJGC facilities. These include ArcInfo and ERDAS Imagine. Should less expensive options be available at Project start-up, then these should be considered only if they are *fully* compatible with other systems used by the collaborating organisations.

227. PRIME would also be equipped with a limited pool of items, such as Global Positioning Systems (GPS), for loan to collaborating organisations. More significantly, in addition to three saloon vehicles for the PM and TA staff, there should be a pool of four wheel drive vehicles for priority use of field study teams from collaborating organisations. These should be allocated according to the field study schedules on a renewable monthly basis.

B). Special Studies (US$ 165,000)

228. As the project progressed, the baseline data would not only be refined during the continuing component activities, but also elaborated upon by studies in more specific local areas, or on more detailed topics that might be required for particular planned implementations. Such studies can only be identified after the baseline data has been evaluated. Accordingly funding provision has been made within the proposed budget for a series of unspecified studies which would be identified and defined after the initial phase of the Unit's activities.

C). Training (US$ 395,000)

229. An important element of PRIME's Terms of Reference would be to ensure its long term viability. It is envisaged that sufficient skills be transferred to PRIME's local staff, through both 'on the job' training during the initial baseline assessment, and via specific externally recruited technical supervision in the following years. As the local capabilities were built up, so the input of external technical assistance would be progressively reduced to minimal levels by the end of the Project's expected life.

230. Training would be required in: data management, integration, analysis, and interpretation; mapping and presentation; GIS procedures (particularly for ArcInfo) and file transfer; as well as remote sensing and image processing. It is envisaged that the personnel recruited for these tasks would also serve as trouble-shooters to solve the potential problems of equipment and software installation and compatibility. Given the technical sophistication of most of these topics, the relevant personnel would almost certainly have to be recruited externally.

231. In order to ensure a smooth and progressive strengthening of local expertise, training input would have to be maintained on a regular basis throughout the proposed Project's life. This would have the added advantage that PRIME staff could be kept abreast of software developments, which will undoubtedly continue to be as rapidly evolving as they have been during the past five years.

D). *Awareness Programmes and Socio-Economic Studies (US$ 410,000)*

232. A primary goal of the PRIME would be to create greater public awareness of the status of Jordanian rangeland resources and the prospects for their rehabilitation and sustainable development. This would require the sensitisation of all levels of society, from pastoralist to politician, to the various issues involved and the difficult choices and compromises that would have to be made if the rangelands are to survive intact.

233. A major public awareness campaign is called for, involving both rural and urban populations, governmental and non-governmental organisation, research institutes and centres of learning.

234. The campaign would include the holding of workshops, participatory surveys and seminars, as well as contributions for radio and television, production of a regular newsletter and press releases, and the production audio of visual programmes for screening on National television and for video display.

i). Workshops (US$ 50,000)

235. In the first instance, a "training of trainers" workshop would be held for Queen Alia Fund regional staff, to familiarise them with the status of Jordanian rangelands and pastoral resources, and examine the options available for rehabilitation and sustainable development. Subsequently, a series of local workshops would be held at community centres across the country to raise the awareness of and obtain feedback from local communities. Other dissemination networks, such as the Noor Al Hussein Foundation, the Royal Society for the Conservation of Nature would also be involved. If possible, representatives of organisations such as the Badia Police, who have close contact with pastoralists in the more remote areas would be included in these exercises.

ii.) Participatory Socio-Economic Surveys (US$ 75,000)

236. QAF staff are well qualified, knowledgeable and widely experienced. They have taken part in a variety of social and economic studies, including a recent baseline socio-economic and animal production survey of the Jordanian rangelands for IFAD[4].

237. The project would build on this collaborative experience and utilise the Fund's extensive network of grass roots contacts to access pastoral communities and bring them into the debate on the future development of Jordanian rangelands. This debate must involve a mutual exchange of information, reflecting the legitimate feelings and aspirations of pastoral communities, whilst at the same time recognising the intrinsic constraints on arid land livestock production, and considering realistic options for rangeland rehabilitation and development.

238. A series of socio-economic studies and surveys of pastoral communities would be undertaken during the course of the project, to complement the findings of the initial baseline survey. These studies would include the establishment of an appropriate sampling frame for monitoring the household economy of pastoral families and the productivity of their livestock, as well as more general surveys to identify communities willing to participate in co-operative rangeland management, and locate areas of rangeland traditionally associated with particular communities.

iii). Seminars (US$ 60,000)

239. During the course of the project a variety of Seminars would be held to discuss the findings of various studies commissioned by the project and sensitise invited participants to the various issues raised. For maximum impact, these Seminars would be targeted at community leaders, influential members of society, academics and professionals in the pastoral resource arena, senior administrators and policy makers.

iv). Radio and TV Programmes (US$ 50,000)

240. In collaboration with Jordanian Television and Radio, independent producers and script writers would assist in preparation of a series topical discussion programmes about pastoral resources, livestock production and rangeland development issues. These discussion programmes should go beyond the conveyance of extension messages, involve the general public and examine issues of competitive land use, land tenure and co-operative community initiative in land use planning.

v). Network Newsletter/Press Releases (US$ 25,000)

241. A network of organisations and individuals interested in Jordanian rangelands and pastoral resources would be identified and a quarterly Newsletter would be produced by

[4] Roger Blench, op. cit.

PRIME highlighting current issues in rangeland and pastoral resource development. These would be illustrated by the suitably tailored output from PRIME's analysis and interpretation activities. Press releases would also be issued via the Ministry of Agriculture and PRIME's collaborating institutions

vi). Audio-Visual Programmes (US$ 150,000)

242. Three 30-45 minute documentary audio-visual programmes on Jordanian Rangeland would be professionally produced as training and awareness videos and for screening on National Television. Topics likely to be covered would include: Review of Current Status, Historical Background and Significance of Range Resources; Contrasting Views of the Pastoralist and Urban Dweller; Land Tenure; Land Use Planning; and Sustainable Development: Prospects for the Future.

Range Assessment and Monitoring

243. The overall objectives of the range assessment and monitoring Sub-Component would be to assist the Jordanian authorities in establishing a baseline, quantitative description of forage vegetation conditions in the rangelands, with an analysis of past and current trends, and in developing a system for monitoring changes which occur under both climatic and human influence through management of livestock and croplands.

244. There is at present insufficient information concerning the dependence of forage productivity on climate, soils and topography (see Annex 3) on the one hand and on the utilisation by livestock (see Annex 4), on the other. Equally, the ability of rangeland forage resources under existing conditions to support livestock remains almost completely unquantified. For assisting the planning of effective management interventions on a nation-wide scale, the existing descriptions of vegetation structure, productivity and dynamics would be extended in a monitoring programme of the rangelands of Jordan as a whole.

245. PRIME would require a more detailed resource assessment than is possible from existing information, if it is to establish a meaningful baseline and monitor changes over the period of the proposed Project. PRIME would also require a better understanding of these relationships in order to identify and target possible means of improving rangeland. Regular monitoring of rangeland vegetation composition and productivity would be needed to complement soils, land use and livestock population.

246. This would be achieved by using a combination of satellite images and ground-based measurements of plant cover and composition. Remote sensing analysis is the most cost-effective method for assessing environmental conditions over a large geographic scale, while ground-based examinations are necessary for directly determining the abundance of palatable forage plants and the suitability of rangelands for livestock.

247. The mapping of land suitability for cropland, rangeland improvement and unimproved extensive grazing of rangelands, as described in Annex 3, would be improved by co-operative effort between the specialities of soil and land use survey and rangeland vegetation study. In particular, the land suitability criteria described in Table A3.4 need to be linked to data on vegetation productivity. This would allow realistic evaluation of land capability.

248. In general, the studies described below are designed to provide a baseline level of information in the first year of the Project. It is at this stage that most input of technical assistance would be provided, in order to set up monitoring programmes and to train Jordanian

personnel in the methods required for their subsequent operation. It is expected that the core technical staff of PRIME would play a role as "guiding" technical assistance when required during PY2-5.

A). Nation-wide Trends in Vegetation Cover and Cropland Extent (US$ 43,493)

Objectives

249. To develop an understanding of the trends in vegetation cover and the extent of croplands in the rangelands on a nation wide basis over the past two decades, and forward through the course of the Project term. The intention is to test the assumptions that there has been a steady trend of decreasing productivity and increasing cropland in the Steppe and Badia rangeland regions.

Proposed Study and Methodology

250. The study would produce estimates of the area of ground in different rangeland types and geographical regions of Jordan, covered by productive native vegetation and by croplands during the spring growing season of several different years, over a timespan covering the last 15-20 years. To achieve this, there would be an analysis of satellite images, from the earliest available date, through to the present, and on during the course of the Project.

251. The proposed analysis would require the purchase of a full set of LANDSAT images, numbering seven in total, of the whole country in spring of each year for four dates: the beginning of the LANDSAT series (1979), midpoint between beginning of the series and the first year of the Project, PY1 and Project Year Five. The precise years chosen for examination would be selected, when possible, on the basis of annual rainfall, such that each year would have roughly comparable rainfall amounts. This would control for effects of rainfall on rangeland productivity, in order to examine longer term trends under the assumed influence of livestock impact.

252. The image signatures of productive rangeland ground cover and of cropland would be determined by ground-truthing exercises undertaken by teams composed of staff from the Royal Jordanian Geographic Centre (RJGC), the Range Division and the Soils and Land Use Division (SLUD), described below.

253. Analysis of the images would be performed by the RJGC, with initial Technical Assistance by a Remote Sensing Specialist. Images for PY1 and PY5 would be purchased under the Ground Truthing Study, while earlier images would be purchased under this Study.

B). Seasonal Patterns of Rainfall and Rangeland Vegetation Cover (US$ 33,623)

Objectives

254. The main aim would be to monitor seasonal rangeland vegetation production in different vegetation types, in relation to rainfall patterns on a spatial scale. This would allow the description of short term responses of vegetation in different rangeland types to immediate rainfall events, indicating which areas of rangeland remain productive and which appear to be suffering from a decline in productive capacity. It would contribute to the land suitability mapping process described in Annex 3, and would provide a backdrop for evaluating the distribution, movement and rangeland utilisation patterns of livestock described in Annex 4.

Proposed Study and Methodology

255. The study would involve using METEOSAT images for estimating rainfall distribution patterns and NOAA/AVHRR images for estimating vegetation biomass production. Initial calibration and subsequent validation of the products from METEOSAT and NOAA would be carried out by the Ground Truthing Study.

256. METEOSAT and NOAA data are received on a daily basis at the National Forecast Centre, Department of Meteorology. It is proposed that satellite data would be collected by NFC and archived every day during the primary growing season, from January to May, of each project year, and amalgamated into three 10-day (dekadal) averages per month. For the remainder of each year, NOAA data would be collected for one dekad per month. Since there is little or no rainfall outside the growing season, METEOSAT data for this period would not be needed.

257. Preliminary processing would be completed at the NFC and further analyses and integration with other data layers would be completed at the RJGC. In return, NFC would receive institutional support in the form of additional computers and data storage equipment (magneto-optical disk drives), as well as backup equipment for the NOAA receiver. RJGC data processing would be paid for at their standard charge-out rates. Technical assistance to establish and supervise the data collection and analysis process would be provided by a Remote Sensing Specialist.

258. The data on spatial distribution of productivity estimates would be made available, through PRIME, to the teams working on land suitability mapping and livestock distributions.

C). Ground-truthing of LANDSAT-MSS and NOAA images (US$ 158,525)

Objectives

259. To validate and enhance interpretation of satellite imagery for long-term monitoring of rangelands.

Proposed Study and Methodology

260. The ground-truthing would involve initial identification of soil colour and albedo classes influencing the reflectance characteristics of LANDSAT and NOAA images. Field work would comprise polygon mapping of homogeneous soil classes, vegetation cover and land use types in different areas of Jordan, using Global Positioning System (GPS) receivers to determine precise geographic locations for linkage with pixel identification on images. Areas for investigation would be chosen to include representative areas from Land Regions (Table A3.2), soil albedo types and vegetation zones, as defined in previous studies.

261. The field teams would include staff from the Range Division and the Soil and Land Use Division, both of the Department of Forests and Range in the Ministry of Agriculture and from the RJGC. Operations would be conducted in both spring and late summer/early winter. Field data collection would include brief descriptions of dominant vegetation cover types, and estimates of percentage ground cover of green vegetation, all vegetation, and plant biomass in broad classes.

262. Attempts would be made to undertake nested sampling. For LANDSAT-MSS calibration, where pixel size is on the order of 80 x 80m, smaller polygons would suffice.

Clusters of such polygons would be combined to provide estimates of vegetation characteristics for the larger pixel size, 1000 x 1000m, on NOAA images.

263. Data analysis would be executed by the RJGC and technical assistance in setting up calibration and validation exercises would be provided by a Remote Sensing Specialist.

D). Ground-truthing of METEOSAT Images (US$ 40,870)

Objectives

264. To provide reliable rainfall distributions, it would be necessary to undertake initial ground-truthing and continued validation exercises of METEOSAT data.

Proposed Study and Methodology

265. This would involve correlation of predicted rainfall from Cold Cloud Duration (CCD) data with matching data from geographically referenced rainfall stations, supplied by the Department of Meteorology. Initially, it would be necessary to estimate appropriate threshold values for CCD from a preliminary dataset of rainfall events during the spring of PY1. This threshold value would then be tested and refined with additional data collected in the same and subsequent years.

266. Data analysis would be executed by the RJGC and technical assistance would be provided by a Remote Sensing Specialist.

E). Monitoring of Vegetation Species Composition and Biomass (US$ 82,940)

Objectives

267. Satellite-based monitoring methods alone cannot provide detail on plant species composition and biomass production, and such data must be supported by measurements of rangeland vegetation on the ground.

Proposed Study and Methodology

268. Sampling sites would be selected, with the technical assistance of a Soils Specialist, from the sample sites in the Level 1 Soils and Land Use Surveys.

269. Sampling would be widespread in the first year, with approximately 3000 sites envisaged, and a reduction in sampling intensity (number of sites visited) in subsequent years contingent on a statistical analysis of similarity. Field work would take place for one month during the spring, with the timing chosen to coincide with peak vegetation biomass, allowing for significant vegetation growth and/or flowering, but to precede intensive grazing by livestock. This would probably be during February to March of any given year. The sites chosen in the first year, or a subset of them, would be revisited in subsequent years.

270. Site selection would involve examining the JOSCIS database at SLUD. Stratification criteria would include soil colour and albedo classes, Land Regions (Table A3.2) and vegetation association types from the existing maps produced by Hunting/SSLRC (1991) and FAO (1991), as well as a representative geographical spread.

271. Soil samples would be collected for subsequent seed germination studies to determine the potential for rangeland recovery.

272. The field effort would involve staff from the Range Division and Soils and Land Use Division of the MoA. Six teams of two technicians, one each from the Range Division and SLUD, would be involved data processing for analysis of species composition and biomass at sampling sites would take place in the Range Division and technical assistance would be provided by a Rangeland Management and Monitoring Specialist.

273. The results would be analysed for spatial patterns and correlation with other data sources. Vegetation maps would be revised accordingly.

F). Development and Refinement of Models of Forage Biomass Production (US$ 20,304)

Objectives

274. Models of rangeland forage productivity incorporating the data from both the Soils and Range Sub-Components would be developed and validated to enable PRIME to provide forecasts of rangeland production for use by strategic planners.

Proposed Study and Methodology

275. Predictive models of rangeland plant biomass production related to rainfall, soil moisture and soil water balance have been developed for arid, semi-arid and temperate rangelands on several different continents. Similar models would be developed from data collected at selected field study sites in Jordan. One hundred exclosure plots are envisaged, which would need protection from disturbance by people and livestock during the growing season and would ideally have associated technical staff involved in ongoing research programmes.

276. Potential sites include the Badia Research and Development Programme, the University of Jordan/ NCARTT Drylands Development Project, a selection of Range Reserves managed by the Range Division of the MoA, and Nature Reserves managed by the Royal Society for the Conservation of Nature. The studies would collect rainfall data, soils and hydrology data and vegetation biomass production data (the latter from small temporary exclosures) during the spring of each year.

277. Data would be processed by collaborating organisations and in the Range Division of the MoA and predictive mathematical relationships developed between vegetation production and soil water balance by PRIME staff. Technical assistance would be provided by a Rangeland Management and Monitoring Specialist in the first year of the Study.

G). Pilot Regulated Grazing Experiments (US$ 44,458)

Objectives

278. Desirable stocking rates for livestock have been approximated by analytical methods, based on the balance between consumption and production rates, but these methods require empirical validation. A more direct and effective technique is to undertake experimental grazing trials, by holding livestock at given known densities and observing the response of the vegetation.

Proposed Study and Methodology

279. The studies would involve monitoring the effects on the vegetation of three different grazing regimes within fenced exclosure plots, ranging from no grazing through moderate to intense levels. It is proposed that the studies be initiated as pilot experiments to demonstrate

the methodology and be undertaken at Range Reserves, Nature Reserves, the Badia Research and Development Programme and other sites, where relations with local communities allow exclosures and controlled stock densities.

280. Thirty fenced and guarded exclosures are envisaged, clustered so as to allow for ready access and ease of protection. The specific sites chosen would represent key vegetation communities of interest to government and private sector decision makers, with some background information from earlier and ongoing studies of forage production dynamics under the Project, or other current research/study programmes.

281. If successful, similar studies could be initiated as part of ongoing programmes under the Range Division in Range Reserves, by the RSCN in selected Nature Reserves and at specific research sites such as the BRDP at Safawi. This research programme could also be expanded under the Development Programme.

282. The methods for measurement of vegetation response would be the same as for the survey of rangeland composition and biomass study, described above. The field measurements and data analysis would be made by staff of the appropriate participating institution, i.e. Range Division of MoA, University Dryland Project, JCO, BRDP and RSCN.

H). Training (US$ 159,200)

Objectives

283. The capacity of Jordanian institutions, particularly the Range Division, to carry out rangeland monitoring is limited at present, and needs to be strengthened.

Proposed Actions

284. Nominated personnel would be trained through both short courses for technical staff on range management and research methods at local institutions and short term refresher programmes in rangeland management and ecology for professional staff at overseas universities. Much would be gained in time, money and flexibility if the relatively numerous cadre of foresters were offered conversion courses in range management.

285. Support would be given for curriculum development and the establishment of a range management course at the University of Jordan. The Faculty of Agriculture has lecturers in rangeland management and dry land agriculture on its staff, but lacks a structured formal programme of rangeland studies. It is envisaged that PRIME would support the formation of a curriculum development committee, comprising representatives of the Faculty of Agriculture, NCARTT, Ministry of Agriculture, Department of Forestry and Range, HCST, RJGC, ICARDA and ACSAD, to prepare an appropriate range management programme for undergraduates, postgraduates and diploma course students.

Soils and Land Use Evaluation and Mapping

286. There is at present insufficient information concerning the relationships between soils, climate, topography and productivity in rangeland areas to assess land in terms of rangeland productivity, potential for improvement, or risk of land degradation and soil erosion.

287. The Pastoral Resources Information Monitoring and Evaluation Unit would require a more detailed resources assessment than is possible from existing information, if it is to monitor changes that occur over the length of the project.

288. PRIME would also require a better understanding of these relationships in order to identify possible means improving rangeland, through restricting cultivation or grazing, conserving water, and reducing soil erosion.

289. Since previous soil surveys and land use studies have been focused on cropland, there is insufficient soils and land use information in steppe and desert areas.

290. Technical assistance in soils and land use survey and soil water balance/soil erosion investigation would be provided through the PRIME. Visits by a specialist in soil data base management would also be made.

291. Training in skills needed for soil and land use evaluation, soil physics, remote sensing, data base management and GIS would be provided through technical assistance and short courses, and Jordanian pedologists would be encouraged to participate in applied research activity relating to rangeland improvement.

292. Facilities in Jordanian institutions would be strengthened to enable them to participate effectively in the following special studies:

A). Strengthening of the Soils and Land Use Division (US$ 130,500)

Objectives

- To upgrade the capability of SLUD provide information relating to rangelands from their computerised data base.
- To promote SLUD and help ensure facilities are maintained over the longer term.
- To foster international collaboration in soils and land use evaluation and monitoring, using GIS and soil water models.

Proposed Action

293. Much of this Sub-Component would involve the Soils and Land Use Division, which is currently in need of substantial strengthening. PRIME would therefore provide technical assistance in soils and land use survey, and soil water balance/soil erosion investigation techniques. Visits by a specialist in soil data base management would also be made. Training in skills needed for soil and land use evaluation, soil physics, remote sensing, data base management and GIS would be provided through regular technical assistance and short courses. A pedologist would be attached directly to PRIME so as to encourage a broader perspective of rangeland improvement issues.

294. A review of computer operating systems, the data base management system and the GIS in use by the Division would be required, following which further training for at least one pedologist, one database specialist and one GIS specialist would be required. It would be important to PRIME that a Pentium standard or better PC computer is available in SLUD, with full upgrade and maintenance support for SPANS Version 6, or SPANS Explorer, when available. The Division's computer programmer would be given training in the software provided.

295. Laboratory facilities would be investigated at NCARTT, which has closer institutional and professional links with SLUD than the Jordan Valley Authority laboratories previously

used. Consideration should now be given to development of a basic capability for soil chemical and physical analysis at NCARTT.

296. The capacity for SLUD to monitor soil physical conditions and soil moisture affecting rangeland rehabilitation would require the provision of facilities for soil moisture measurement and monitoring using tensiometers, sediment sampling and a tension infiltrometer.

297. Links with the Soil Survey and Land Research Centre (University of Cranfield, UK) and the Soil Science Departments of a number of universities would be maintained to develop soil physics, GIS, remote sensing and modelling capabilities, and support and encourage research in soil physics and land degradation.

298. A Division pedologist would be trained, partly overseas, to work specifically with the data base/GIS specialists. A soil information specialist would be provided to organise this training. In addition all pedologists would receive some training in data base/GIS work.

B). Land Suitability Mapping (US$ 239,000)

Objectives

299. Both pastoralists and policy makers need to know which land is most suitable for supporting livestock, and which might be put to alternative uses. Land suitability classification provides a simple ranking of land, in terms of relative repayment capacity when used for a specified purpose, in this case for providing feed to grazing animals. It is based on information about soil or land characteristics and climate, and how these affect forage production. This information is obtained from soil survey and analysis of climate data. The accuracy of the classification depends on the detail of the information available.

Proposed Study

300. The land suitability criteria for rangeland and for rainfed cropping currently used by SLUD would be revised to incorporate differences in soil moisture regime as influenced by runoff and infiltration rates. Information provided by vegetation may also be incorporated. Provisional new land suitability classifications would be made for all areas mapped at 1:50,000 scale.

301. Since large areas of Jordan have only been mapped at reconnaissance level, areas for more detailed rangeland suitability assessment would be selected for semi-detailed soil survey An estimated 2,000 km^2 of land, shown by reconnaissance soil survey to be suitable for improvement, or identified as being threatened by increased cultivation or urban expansion, would be selected for survey in the second and third year of the Project. Ten per cent of the observations would be fully described profiles. Soil chemical and physical analysis would be carried out to determine soil fertility and water holding capacity and to help in the assessment of erosion risk. This work would be carried out by pedologists from SLUD working closely with the PRIME unit.

302. Satellite imagery would be obtained for the new Study areas, georeferenced and enhanced. RJGC would be assist with the image processing. All information would be entered on the JOSCIS, and maps would be digitised and incorporated in the SPANS GIS.

303. In areas not covered by the new study areas, reconnaissance level land suitability classification would be carried out based on existing soils information and extrapolation from sample areas.

C). Monitoring Soil Water Balance and Soil Erosion Effects (US$ 131,000)

Objectives

304. Two major indicators of permanent degradation of rangeland are net reduction in rainfall quantities retained in the soil for plant growth and net loss of fertile topsoil by erosion. Erosion by both wind and runoff are important in the drier parts of the region particularly where infiltration rates are low.

305. A proportion of the rainfall actually falling on rangeland is lost by evaporation from standing water in enclosed drainage basins. Water harvesting practices, including small dam construction or diversion structures, would reduce these losses and the savings would need to be monitored.

306. Once soils have been mapped and the inherent soil properties influencing rangeland productivity have been determined, attention would focus on the water balance. Water balance studies are required to analyse and extrapolate the effects of improvement measures and determine their sustainability and influence on moisture retention for plant growth, erosion sedimentation and groundwater recharge.

307. Contour furrows can reduce runoff and soil erosion, but baseline estimates of present losses and gains of both water and soil would need to assessed in sample areas to monitor their effectiveness.

308. The objectives of this study would be to provide detailed information concerning the water balance and erosion in sample areas in the steppe and desert areas, to help identify improved management practices and their effectiveness in overcoming constraints limiting productivity.

Proposed Study

309. Water balance and soil erosion are influenced by soil physical properties, rainfall intensity and size of catchment. Collaboration between SLUD, the agrometeorologist and a hydrologist from WAJ would be required to help quantify rainfall intensity, soil water holding capacity, soil erodibility, evaporation, runoff, recharge and water used productively by rangeland vegetation. The water balance would be determined at a series of point locations, and aggregated using spatial analysis capabilities of the SPANS GIS.

310. At least three sample catchments would be identified, and slopes, rainfall, soil water content and runoff, and crop cover would be measured. Infiltration and soil hydraulic conductivity would be measured at several sites in each catchment using a tension infiltrometer.

311. Potential evapotranspiration would be calculated, and rainfall erosivity would be estimated from rainfall intensity-duration estimates at all raingauge stations located in the steppe and desert areas. An automatic weather station and two raingauges would be installed.

312. The data sets obtained from the investigation work would be applied to validate alternative models of soil erosion and soil water use by rangeland vegetation, and also used in hydrological models used by the Water Authority of Jordan to estimate recharge.

313. This work would be carried out jointly by: an agrometeorologist from the Meteorological Department; a hydrologist from Water Resources Department of WAJ; and a

pedologist from SLUD, assisted by a soil and water management specialist provided under technical assistance during the first two years of the study.

D). Interaction of Cropland and Rangeland (US$ 19,000)

Objectives

314. Cultivation is thought to contribute to the degradation of rangeland, but no quantitative information is available concerning the extent of cultivation in rangeland areas, and it is not known if the effect of cultivation on rangeland productivity is permanent. To justify policies limiting cultivation in the drier areas, more information on the influence of cultivation on rangeland productivity and on any permanent degradation of rangeland would be required.

315. There is information from a variety of data sources held by SLUD on historical trends in cultivation practices. These include records of field observations made in 1956, aerial photography and satellite imagery, and the SPANS database.

316. The main objective of this investigation would be to provide PRIME with a sound basis for defining agroecological zones, and provide supporting land use data for the analysis of past trends in cultivation practices.

317. Cropping may also affect soil fertility, more information about soil fertility of rangeland and cropped areas would also be obtained to determine its importance.

318. Water harvesting practices and irrigation possibilities alter land suitability. Ways in which these possibilities are taken into account in planning land use must be determined.

Proposed Study

319. Information available from aerial photography, satellite imagery, ground survey, and the JOSCIS database would be used to quantify the extent of cultivation in different years for sample areas covering all land regions.

320. During soil survey work in new study area, soil pH, soil organic matter and available phosphorus would be determined. The effectiveness of rainwater harvesting and irrigation on improving cropping potential would be investigated by monitoring soil water content, runoff and erosion.

321. This work would be carried out by SLUD pedologists under the supervision of the senior pedologist attached to PRIME, in collaboration with the University of Jordan.

Livestock Related Studies

322. The livestock information available in Jordan is extensive, and, with a few exceptions, of sufficient quality and depth to provide a satisfactory basis for continued monitoring and for development planning.

323. There are, however, some gaps which need to be plugged, and there is potential for further analysis of existing data. Five areas of livestock related study have been identified:

- Assessment of livestock distributions, in relation to rangeland and cropping, together with verification of existing population data;
- Geo-referencing existing livestock data held by DoS;

- Further examination of the socio-economic context of livestock management, livestock ownership patterns, and perceived constraints on production;
- Investigation of livestock's role in the household economy and examination of livestock marketing strategies, combined with the monitoring of animal health and herd productivity;
- Reviewing the current status of semi-intensive forms of livestock production (including quasi feedlots) and identification of appropriate monitoring criteria.

324. Some institutional strengthening of the national capacity for epidemiological analysis and detection of sub-clinical infections would also be required and is considered in the following Sub-Component.

A). Livestock Distribution, Movement and Management (US$ 600,000)

325. Livestock numbers that would provide high resolution animal distribution or movement data are required. This would be used to establish the baseline levels of rangeland resource utilisation in relation to its actual and potential production, its suitability and its phenology. Once defined, the relationship would be used to predict rangeland utilisation by livestock, using remotely sensed vegetation data and assessments of range suitability derived from the other Study Sub-Components. This process would help to establish the potential of the rangelands to support livestock, and to define the changes in such potential that might accrue from rangeland rehabilitation measures.

326. In order to link with vegetation or soil derived land suitability information, the resolution of livestock distribution data would need to be of the same order of magnitude as satellite imagery, or 1:250,000 soil maps. Also, in order to provide movement data relative to range distribution, surveys would have to be repeated at least twice in one year, and would be needed for quite large areas in order to accommodate regional variability in rangeland production and extent. All such studies would require further understanding of the socio-economic context.

Objectives

327. The major objectives of this study would thus be to:

i) To assess livestock distribution patterns in relation to the availability of range and cropland resources;
ii) To assess livestock movement in relation to changes in the distribution of range and cropland resources;
iii) Using the results from i) and ii) above, to assess rangeland resource utilisation by livestock in relation to range and crop land extent, and phenology;
iv) To provide independent verification of existing DoS livestock population estimates; and
v) To investigate socio-economic and economic factors influencing livestock keeping and management in relation to range resource utilisation.

Possible Methodologies

328. Amongst the primary information required from a livestock survey is an estimate of numbers and a description of distribution patterns. These data should be collected in as short a time as possible, to minimise the effects of animal movement, and should be assembled in such a way as to enable comparisons with both past and future figures.

329. Animal population figures can be derived from a variety of information sources, ranging from administrative records, such as taxation and vaccination returns, to data collected by more objective methods of assessment, based on ground or air survey techniques.

330. Population estimates derived from indirect ground survey techniques must be treated with caution. Ground transects are also difficult to interpret and are generally considered to be of limited value.

331. Ground based census methods of the sort used by DoS rely on accurate enumeration and reliable co-operation of the respondents. Both may be compromised by factors beyond the control of the survey designers, or enumerators. Ground based techniques are also very expensive of manpower, equipment and time, especially if a series of livestock population estimates are required within a short period, in order to assess movement patterns, and if the enumerators have to visit remote areas in order to count animals.

332. An alternative approach would be the use of low level aerial survey, which provides an objective, rapid and cost-effective means of assessing livestock populations over extensive land areas. One particular technique, known as Systematic Reconnaissance Flights (SRF), has been widely used to assess livestock, wildlife and human habitation from flight levels of between 450-1,500 feet (150-450 meters) above ground. At these heights, visibility is sufficient to differentiate, for example, small ruminants and calves, the ground is rarely obscured by clouds, and, unless the canopy cover is complete, the angle of view is generally sufficient to see under such obstacles as trees.

333. Daily survey flights would be timed to ensure that the majority of the animals were grazing, rather than agglomerated in large groups round the owners' camps. Any such large groups would be both counted by the observers, and photographed in order to double check the accuracy of observer estimates.

334. SRF surveys are based on sampling animal numbers in a regular lattice of grid cells covering the entire survey area. The size of each cell depends on the desired sample intensity for a given survey, and commonly vary from 2.5x2.5 kilometres to 20x20 kilometres, resulting in sample percentages of between 5-20%, according to flying height. Large scale examples of surveys using this technique include the Nigerian National Livestock Census, Kenya Rangeland Ecological Monitoring and numerous other studies across the Sahel in Ethiopia, Mali, Niger, Tchad, Senegal and Sudan.

335. SRF techniques have been tried and tested in many dryland environments and, in addition to livestock and wildlife, can provide detailed and reliable estimates of many agricultural and environmental parameters. However, information concerning such factors as livestock ownership patterns, animal production parameters, production constraints and details of animal husbandry, must still be obtained on the ground.

336. An integrated methodology is required, which combines features of both aerial and ground survey to maximum advantage, whereby the rapid extensive and systematic coverage from the air provides an objective basis for the effective targeting of ground studies. This process ensures optimal use of available manpower, and minimises the time wasted in examination of the less important regions.

Proposed Surveys

337. The objectives of the proposed study of livestock distribution and movement cannot be achieved using existing methods of data collection in Jordan for the reasons outlined above.

338. It is, therefore, proposed to conduct low level aerial surveys at two periods during the spring of PY1 - in February when the rangeland is at its greenest, and again in April, towards the end of the main rangeland grazing period. The surveys would provide assessments of livestock densities at a resolution of 4 km, together with estimates of natural vegetation cover, human habitation and surface water.

339. This strategy would give two points of reference for rangeland utilisation in relation to livestock numbers, as well as allow for the assessment of the way animals are moved in response to range condition. The second survey would also coincide with one of the bi-annual livestock counts carried out be DoS, and so provide the opportunity to validate their figures.

340. Ideally these surveys would cover the entire rangeland area of the country, but the resolution required to be compatible with the information collected by the soils, land use and rangeland Sub-Components would make such a large survey prohibitively expensive. It is thus proposed that the coverage be limited to Mafraq Governorate, which occupies most of the north and east country.

341. The specification of an entire Governorate would allow a direct comparison of the survey results with those from the routine DoS survey scheduled for April. In addition, Mafraq contains a wide range of vegetation types and rainfall bands, so is more representative of the country as whole than most other Governorates. Mafraq is also logistically convenient in that the BRDP's Safawi Field Centre is at its geographical centre, with an airstrip, and collaborating personnel.

342. The socio-economic environment is of major significance, and whilst it has been addressed to an extent by the 1995 IFAD survey, remains unclear, particularly in view of likely changes in conditions caused by the lifting of feed subsidies. Accordingly, a ground survey would be undertaken during the second of the aerial surveys, designed both to assess the ratios of sheep and goats in small ruminant herds observed from the air, and obtain socio-economic information, including livestock ownership patterns, animal production parameters, production constraints and details of animal husbandry in the areas surveyed. Sample locations and sampling intensity would be decided after preliminary reconnaissance flights.

343. The proposed budget allows for a third tranche of surveys - either aerial counts or substantial additional socio-economic surveys. The choice between these alternatives would depend largely upon the results obtained during the preceding aerial and ground work. The objectives would be determined by whether or not the initial surveys confirmed the Government data on productivity, distributions and numbers.

344. As well as continuing the investigations started in the initial surveys, additional ground work could be designed to complement the other livestock monitoring studies envisaged - specifically the health monitoring (see below), and to identify any changes in livestock marketing and management practices during the life of the proposed project that may be consequent upon economic developments. These would provide a detailed 'snapshot' of prevailing conditions, as opposed to the temporal information provided by the proposed herd monitoring.

345. Further aerial survey work could either complement the first two counts, by being conducted during the period when livestock are feeding on crop residues in June and July, or at the end of the Project's expected life, to enable an assessment of any medium term changes in range utilisation.

346. The latter option's major advantage would be in establishing changes in animal numbers during the Project's expected life. This, however is viewed as a secondary objective of the proposed studies. Firstly, the output from the verification of DoS data carried out during the April aerial survey could be used, if required, to correct DoS data collected in subsequent years. Secondly, precise numbers are only needed to establish resource utilisation models, rather than population estimates *per se*. Thirdly, inter-annual variability in rainfall, and consequently in the productivity of the rangeland, may well invalidate any but the broadest comparison of animal numbers from two years.

347. A third survey in June or July, would, in contrast, provide valuable information about the utilisation of crop-residues by livestock. This is an important part of the management system in the proposed survey area, and would help establish the relative contributions of natural rangeland and cropping to the annual livestock feed budget.

348. It is suggested that the choice between these, and other options (see Annex 4) is made during the pre-implementation phase of the proposed Project, and should be based on the requirements of the Ministry and other collaborating institutions.

349. Training in survey methodology, design and execution would be provided to counterpart staff, so that a national capability would be established, for future use. Initially this would consist of limited on the job training for counterpart field staff. Towards the end of the proposed survey programme, a training course lasting two weeks would be run, detailing the steps involved in setting up and executing an aerial survey, processing the results and analysing the data obtained.

B). Geo-referencing Existing National Livestock Data (US$ 5,000)

Objectives

350. To geo-reference existing livestock data held by DoS.

Proposed Study

351. In order to make the DoS livestock data more compatible with, for example, vegetation data derived from satellite imagery, existing records would have to be geo-referenced. Currently they are identified by village name, but the map co-ordinates are not known. It is therefore proposed to provide limited funding to the Livestock Statistics Section to acquire topographic maps upon which the location of each census point would be identified. Their latitude and longitude co-ordinates could then be extracted and added to the present data base. Short term technical assistance, either from PRIME or from the Royal Jordanian Geographic Centre, would be required to oversee the initial stages of this process, and to ensure that the data produced was in a format compatible with PRIME's central data bank.

C). Detailed Herd Monitoring (US$ 50,000)

Objectives and Rationale

352. Regular herd production and health monitoring requires the close collaboration of herders and owners, which can only be achieved by careful explanation of aims and objectives, and sensitive soliciting of herders and owners opinions and perceptions. Herd monitoring thus allows for the investigation of animal productivity parameters, and provides an opportunity to establish a dialogue with the owners.

353. From information currently available it is difficult to assess the relative importance of livestock production in the pastoral household economy. Less is known about the decisions influencing marketing of livestock. These topics can only be investigated by establishing close contact with pastoralists on a regular basis.

354. Detailed data on the sub-clinical incidence of several small ruminant diseases are scarce. In particular, the potentially synergistic effects on production and fertility of infection by more than one disease is postulated but has not been substantiated. These can only be investigated by continuous examination of a number of known animals.

355. Relatively few mechanisms exist in Jordan to assess pastoralist perceptions to innovation, possible interventions, or awareness of rangeland issues, on a regular basis.

356. The objectives of the proposed study are thus to:

- assess animal health - particularly the sub-clinical incidence of PPR, FMD and Blue Tongue and their effects on fertility and weight gain;
- examine marketing strategies;
- establish a dialogue with pastoralists to sound out opinion about rangeland issues and options for sustainable development, and for guidance in the formulation of a national awareness programme.

Proposed Study

357. BRDP and JCO are currently conducting a detailed monitoring study of animal productivity and health in some 20 flocks around the Safawi Field Centre, which has the full co-operation of local stock-owners.

358. It is proposed that the number of flocks monitored should be increased to 40-50, and that existing informal socio-economic aspects of the study should be strengthened and expanded to include: examination of marketing decisions at the farm gate level, and assessment of the relative importance of livestock production in the household economy.

359. Regular meetings between study team staff and stock owners would also be organised at which rangeland issues would be presented by PRIME personnel, and responses to proposed solutions to rangeland degradation assessed. These gatherings would be used to sound out pastoral opinion on the most effective ways of disseminating PRIME's findings.

360. A full time livestock specialist, an assistant, and eight part-time, village-based, staff would be needed. A four wheel drive vehicle would be also required, which would be provided from the PRIME pool.

D). Intensification and Marketing (Special Studies Funding)

Objectives

361. To assess the current status of commercialised feedlots and semi-intensive sheep fattening operations; identify appropriate indicators for future monitoring; and provide a general review of livestock marketing in Jordan.

Proposed Study

362. One of the proposed mechanisms for destocking the Jordanian rangelands is the removal of excess lambs produced each year from the rangelands, for fattening at commercial feedlots.

363. Given that feed supplementation and sheep fattening is common practice throughout much of the country, it is obviously important to define and establish exactly what is meant by a commercial feedlot, and to devise an appropriate framework and methodology for monitoring changes anticipated for the future.

364. This form of intensified livestock production clearly needs to be considered in the wider context of livestock trade and marketing, which includes both imports and exports, as well as animals in transit. Whilst the Ministry of Agriculture and Department of Statistics collect and publish some relevant trade and marketing data, these are considered to be inappropriate for monitoring detailed changes in the livestock production system.

365. A special study is therefore propose to examine the current status of commercialised feedlots and sheep fattening operations, identify appropriate indicators for future monitoring, and provide a general review of livestock marketing in Jordan.

366. The study is viewed as being complementary to the ground surveys proposed above in that it would concentrate more on the management of livestock when they are not utilising natural resources. It is seen to be of particular relevance if the proposed Development Programme is actually implemented, and should only be undertaken in that event. Accordingly the funding would be from the Special Studies budget.

367. It is envisaged that investigations would be undertaken as an independent short-term consultancy, involving the collaborative inputs of a livestock production specialist and a livestock economist, and the supervision of a programme of postgraduate field research.

Institutional Collaboration and Additional Support (US$ 227,000)

368. Most of the studies envisaged would be through formal collaboration with a number of government and non-governmental departments. PRIME would provide technical assistance and training in skills including soil, rangeland and land use evaluation, soil physics, remote sensing and ground truthing, livestock resource assessment; data base management and GIS use.

369. Additional support would be provided through the commissioning of selected studies. Jordanian institutions would provide trainees and facilities for special studies involving agrometeorology, soil, rangeland and land use mapping, remote sensing and GIS and technical support to PRIME. Facilities in Jordanian institutions would be strengthened to enable them to participate effectively.

370. During preliminary discussions with Mission members, a number of organisations have expressed interest in collaboration on a cost recovery basis; access to their facilities; or have offered significant logistic or technical support. These include the Meteorological Department; the Badia Research and Development Programme of the Higher Council for Science and Technology; the Royal Jordanian Geographic Centre; the Queen Alia Fund; and the Noor al Hussein Foundation.

371. The majority of proposed activities thus involve the provision of staff, equipment, operating funds or technical assistance to the collaborating institutions - HCST, RJGC, DoS, MoA, University of Jordan, and Meteorology. Accordingly a very substantial fraction of the proposed Project is, in effect, institutional support in one form or another.

372. In addition to the capacity building activities provision of equipment and additional personnel integral to the four other components (PRIME, Range Assessment and Monitoring; Soils, Water and Land Use Evaluation and Mapping, Livestock Studies), the Proposed project would also provide direct institutional support the Department of Meteorology; the Royal Jordanian Geographic Centre; the Veterinary Department; and the Ministry of Water Irrigation, as outlined below

A). Animal Health Monitoring, Veterinary Department (U$ 101,000)

Objectives

373. To strengthen animal health monitoring capacity, clear the backlog of unprocessed data, and expand epidemiological investigations and analysis, with special emphasis on detection of sub-clinical infections in small ruminant populations.

Proposed Actions

374. It is proposed to enhance the processing and analysis capabilities of the existing Epidemiology and Production Monitoring Section of the Veterinary Department in order to improve the scope and throughput of animal health statistics, and to clear the backlog of unprocessed information. This would involve the provision of two additional data processing personnel, a qualified veterinarian with experience in analysis and interpretation of epidemiological information, computer hardware and software upgrades.

375. Particular attention would be given to enhancing Departmental capabilities in the recognition and diagnosis of sub-clinical infections of Foot and Mouth Disease, Peste des Petits Ruminants and Blue Tongue, which are generally thought to be the most debilitating diseases affecting small ruminants in Jordan today.

376. Close co-operation with JCO veterinary staff and BRDP personnel, conducting the Detailed Herd Monitoring Study (see above), will be required to establish appropriate methods and effective procedures for disease surveillance.

377. Short-term technical assistance from the software designers would be required in order to integrate the present data base into the upgraded software, and to refine the currently available skills in analysis. The output of the strengthened Division would be made available to PRIME's central data bank.

B). Satellite Image Processing Capacity, Meteorological Department (US$ 76,000)

378. In order to be able to provide the NOAA/AVHRR and METEOSAT data required for the proposed Range and Soil studies, the Meteorological Departments existing capacity would have to be enhanced significantly. Existing computer hardware and software would need to be upgraded and additional data storage capacity provided. In addition, as a continuous supply of imagery would be required for input to the other studies, it may be prudent to provide a standby satellite receiving station in case of malfunction.

379. The extra work load imposed by the regular capturing and processing of both NOAA and METEOSAT data would be beyond the capacity of existing personnel. It is therefore proposed to provide funding for a meteorologist/data analyst to assist in the proposed work.

C). Equipment for RJGC (US$ 8,000)

380. As it is proposed that RJGC be provided with the satellite data produced by the Meteorological Department, the Centre would need to be provided with computer hardware and compatible data storage equipment. Given the volume of data to be processed, it would also require an additional workstation or equivalent hardware platform.

D). Equipment for the Ministry of Water and Irrigation (US$ 5,000)

381. Both the Soils and Range study components would require a significant amount of climatic, hydrological and groundwater information, additional dedicated computer facilities would be provided.

E). External Training (US$ 30,000)

382. It is envisaged that a number of government staff involved in the proposed Project will require additional short-term training, most probably through the medium of external training courses. The precise details of these requirements cannot be defined until the specific personnel are identified, and their particular requirements assessed. As a result, blanket provision has been made within the proposed costings to meet the expected requirement.

V. PROJECT IMPLEMENTATION, ISSUES AND RISKS

PROJECT IMPLEMENTATION

383. In Section III, it has been pointed out that the Ministry of Agriculture is likely to be reorganised in the reasonably near future, in order to conform with the conditions of the Structural Adjustment Plan. Accordingly, a precise institutional framework for the proposed Project cannot be proffered at present. The first step of any implementation, assuming suitable funding, would therefore be to finalise the institutional environment within which the Project would operate. This process would be undertaken by representatives of GoJ, NGOs and the funding agency or agencies, and would include defining the specific authorities to which PRIME would report, as well as identifying an acceptable site for the Unit's offices.

384. At this stage it would also be essential to establish the degree of PRIME's institutional and financial autonomy, and to define any broad operational guidelines (such as salary structures and procurement conditions) that might be relevant. It would also seem advisable for high level discussions between the various co-operating organisations to be instituted, in order to ensure agreement between the major players on substantive issues at the Project's inception.

385. Thereafter, the most important requirement would be to constitute the Steering Committee, and, with its approval, to appoint the Project Manager and Senior Project Officers. These staff would then be charged with selecting the junior personnel and setting up the Unit Offices, whereupon the technical assistance personnel would be nominated.

386. The primary tasks for the Project's staff would be negotiating formal agreements for data access, acquisition and exchange with the requisite Ministries and NGO's to be involved in the Project's main work programme; the acquisition and commissioning of the Unit's equipment; and the preliminary data collection and collation (see also Issues and Risks, below). As discussed in Section III, the staff appointments would be for a limited period of say six months, and their extension would be conditional on the successful accomplishment of these initial goals.

387. The start up implementation activities are summarised in Table 2, below.

Table 2: Start-up Implementation Activities

STEP	ACTION	STEPS TO BE ACCOMPLISHED FIRST	IMPLEMENTING PERSONNEL
1a	Finalise Institutional Arrangements	Acquisition of Funding	GOVERNMENT
1b	Appoint Project Manager		NGOs
1c	Assign Office Space and Location		FUNDING AGENCY
1d	Appoint Steering Committee		
2	Appoint Local Staff	1	PM/Steering Committee
3	Appoint Expatriate Staff	1 and 2	PM/Steering Committee
4	Set Up Collaborative Agreements	1 to 3	PM/Senior PRIME Staff
5	Implement Office Arrangements	1 to 3	Senior PRIME staff
6	Acquire PRIME equipment/	1 to 5	Senior PRIME staff
7	Collect and Collate existing data	Only if 1 to 5 in 6 months	Senior PRIME staff
8	Set up GIS data base	Only if 1 to 5 in 6 months	Senior PRIME staff
9	Implement work programmes		Senior PRIME staff
10	Set up awareness programmes		Senior PRIME staff

PROJECT SCHEDULE

388. A chronogramme of the proposed Project activities, subsequent to start-up, is shown in Table 2, below.

Table 3: Proposed Project Schedule of Activities

Project Year	1			2			3			4			5		
Month	6	12		18	24		30	36		42	48		54	60	
PRIME															
Start Up	x														
Accumulating Available Data	x	x													
Setting up GIS	x	x													
Baseline Surveys		x	xx	xx		x	x	x		x	x		x	x	
Production of Resource Assessment			xx	xx		x	x	x		x	x		x	x	
Analysis and Interpretation		x		x	x		x	x		x	x		x	x	
Study Sub Components		x	xx		xx	xx		x	x		x	x		x	x
Awareness Programmes				x	x		x	x		x	x		x	x	
Socio-Economic Studies				x				x							
Training	x		xx	x	x		xx	xx		xx	xx		x	x	
RANGE ASSESSMENT AND MONITORING															
Ground Truthing LANDSAT and NOAA Satellite Imagery	x		xxx	xxx	x		x	x		x	x		x	x	
Ground Truthing METEOSAT Imagery			xx	x	x		x	x		x	x		x	x	
Assessment of Trends in Vegetation Cover			xx												
Monitoring Rangeland Vegetation (NOAA)			xx	xx	xx		x	x		x	x		x	x	
Monitoring Rangeland Species Composition and Biomass	x		xx	x	x		x	x		x	x		x	x	
Development of Forage Biomass Production Models				xx	xx		x	x		x	x		x	x	
Regulated Grazing Experiments										x	x		x	x	
SOIL AND LAND USE EVALUATION AND MAPPING															
Strengthening Soils and Land Use Division	x		xxx	xxx	xx		xx	x		x	x		x	x	
Land Suitability Classification	x		xxx	xxx	x		x								
Water Balance Study				xxx	x		x	x		x	x		x	x	
Interaction of Cropland and Rangeland				xx	x		x	x		x	x		x	x	
LIVESTOCK RELATED STUDIES															
Geo referencing DoS Data	xx														
Livestock Movement, Distribution and Management	xx		xx	xx	xx		xx	xx							
Detailed Herd Monitoring				x	x		x	x							
Intensification and Marketing										x	x		x	x	
INSTITUTIONAL COLLABORATION AND SUPPORT															
Dept of Meteorology	x		x	x	x		x	x		x	x		x	x	
Ministry of water and Irrigation	x		xx												
Veterinary Department	x		x	x	x		x	x		x	x		x	x	
Royal Jordanian Geographic Centre	x														

ISSUES AND RISKS

389. Though considering the proposed implementations set out in the Development Programme's Formulation Report is outside the present Terms of Reference, it became apparent during the Mission's investigations that rangeland destocking on any large scale may require a number of new government policy initiatives. These might include, for example, strategic pricing for different categories on livestock at the slaughterhouse, or some adjustment to the current policy on land claims by both pastoralist and arable farmers.

390. It has, however, been assumed that considering these and similar issues are more within the remit of the main Development Programme, and so have not been included within PRIME's proposed functions. As a result, no provision has been made within the proposed budget to fund them. Should the Development Programme begin during the initial phases of proposed Project, then these topics could be addressed collaboratively by both Programme and PRIME personnel.

391. If however, the proposed Development Programme starts well into PRIME's life, it may be desirable to include within PRIME's design a series of additional objectives centred on detailed analyses of possible policy alternatives, and an in depth assessment of the land tenure situation within Jordan. These could be undertaken alongside the Proposed project's initial pastoral resource assessment phase and be integrated, to some extent, with the proposed socio-economic studies, though these would have to be expanded. However, additional studies would also be required.

392. Given the seasonal nature of the rangeland, and its utilisation by livestock, the scheduling of PRIME's initial tasks - establishing collaborative agreements, identifying the personnel involved, and installing and testing the requisite equipment- would have to be carefully planned in order to ensure the Unit's functionality by the time the baseline assessments would need to begin.

393. Several of the organisations approached by Mission members expressed initial interest in funding the proposed Project (see also Annex 1). These included GTZ and the EU. The latter was especially supportive, particularly in respect of the Soils and Land Use Studies Component, because of its earlier involvement with the National Soils and Land Use Project. Indeed several requests for proposals had already been passed to the relevant Department of the MoA, but had yet to receive any response.

394. In this context, during the Mission's visit, Jordan had been invited to join the group of countries eligible for support under the Mediterranean Environmental Technical Assistance Programme (METAP), which is funded by a consortium of major international donors. Projects which incorporate beneficiary participation, natural resource management and conservation are amongst those which would qualify for assistance from this source. All three of these criteria are central to PRIME's proposed objectives.

395. The proposed Project would require a number of additional issues to be resolved before implementation. Many of these issues would be minimised by sufficient project autonomy at financial and institutional levels. They include:

- a). Collection of the data central to the Unit's analysis and interpretations may have to be authorised by relevant authorities;
- b). The members of PRIME's Steering Committee should be identified and appointed.
- c). Permissions and permits for the proposed low level aerial surveys must be obtained.

396. A number of risks may be associated with the proposed Project. These may include the following:

- a). Unless collaborative agreements are in place in time to access the relevant data by early in Project Year 1, data collection would not be possible, and the requisite studies could not be commissioned;
- b). A regular supply of real time satellite data must be available in suitable format as a supply of primary information;
- c). The relevant parts of Soils and Land Use SPANS GIS database must remain accessible and sufficient interpretative skills should be available. The

feasibility of converting of the data into formats compatible with other, more widely used GIS software should be confirmed;

- d). Sufficient political support from government and non-government institutions must be assured;
- e). The conditionalities and restrictions on disbursement of Project funds should be carefully examined before agreement is reached. The unit cost of many of the items required on a regular basis for input to PRIME (e.g. satellite imagery scenes) are above the local authorisation limits set by some funding agencies. Reference to central agency office for permission to acquire such items could seriously hamper the effectiveness of studies which, by their very nature, are dictated by seasonal deadlines.
- f). Adequate post-project funding should be available in order to maintain and utilise the skills developed during the proposed Project's life;
- g). The Unit's personnel must be appointed in accordance with the Project's TOR;

397. A list of contacts established by the Mission members during their stay in Jordan is provided in Appendix 3 to facilitate follow-up activities.

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APPENDIX 1: SYNOPSIS OF THE UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION

1. Desertification is defined as land degradation in arid, semi-arid, and dry sub-humid areas, caused primarily by human activities and climatic variations. It does not refer to the expansion of existing deserts. Degradation occurs because dryland ecosystems, which cover more than one third of the world's land area, are extremely vulnerable to over-exploitation and inappropriate land use. Poverty, political instability, deforestation, overgrazing, and bad irrigation practices can all undermine the land's fertility.

2. Combating desertification is essential to ensuring the long-term productivity of inhabited drylands. Unfortunately, past efforts have too often failed, and around the world the problem of land degradation continues to deteriorate. Recognising the need for a new start, over 100 governments have signed the United Nations Convention to Combat Desertification, which aims to promote effective action through innovative local programs and supportive international partnerships. The convention will come into effect 90 days after it has been ratified by 50 countries, which is anticipated by 1997.

3. The treaty acknowledges that there are no easy solutions and that there will be no quick fixes in the fight against desertification. This is because the causes of desertification are many and complex, ranging from international trade patterns to the unsustainable land management practices of local communities. Real and difficult changes will have to be made, both at the international and the local levels.

4. Countries affected by desertification will implement the Convention by developing and carrying out national, sub-regional, and regional action programmes. Criteria for preparing these programmes are detailed in the treaty's four regional implementation annexes for: Africa (considered a priority because that is where desertification is most severe), Asia, Latin America and the Caribbean, and the Northern Mediterranean.

5. Drawing on past lessons, the Convention states that these programmes must adopt a democratic, bottom-up approach. They should emphasise popular participation and the creation of an enabling environment designed to allow local people to help themselves to reverse land degradation. Governments will remain responsible for creating this enabling environment. They must make politically sensitive changes, such as decentralising authority, improving land-tenure systems, and empowering women, farmers, and pastoralists. They should also permit non-governmental organisations to play a strong role in preparing and implementing the action programmes. In contrast to many past efforts, these action programmes must be fully integrated with other national policies for sustainable development. They should be flexible and modified as circumstances change.

6. The Convention's action programmes will be developed through consultations among affected countries, donors, and intergovernmental and non-governmental organisations. This process will improve co-ordination and channel development assistance to where it can be most effective. It will also produce partnership agreements that spell out the respective contributions of both affected and donor states and of international organisations.

7. Developed countries are expected to encourage the mobilisation of substantial funding for the action programmes. They should also promote access to appropriate technologies,

knowledge, and know-how. The need for co-ordination among donors and recipients is stressed because each programme's various activities need to be complementary and mutually reinforcing.

8. The Convention opens an important new phase in the battle against desertification, but it is just a beginning. In particular, governments will need to regularly review the action programmes. They will also focus on awareness-raising, education, and training, both in developing and developed countries. Desertification can only be reversed through profound changes in local and international behaviour. Step by step, these changes will ultimately lead to sustainable land use and food security for a growing world population. Combating desertification should be seen as part of a much broader objective: the sustainable development of countries affected by drought and desertification.

ARTICLE 5: OBLIGATIONS OF AFFECTED COUNTRY PARTIES

9. In addition to their obligations pursuant to article 4, affected country Parties undertake to:

- (a) give due priority to combating desertification and mitigating the effects of drought, and allocate adequate resources in accordance with their circumstances and capabilities;
- (b) establish strategies and priorities, within the framework of sustainable development plans and/or policies, to combat desertification and mitigate the effects of drought;
- (c) address the underlying causes of desertification and pay special attention to the socio- economic factors contributing to desertification processes;
- (d) promote awareness and facilitate the participation of local populations, particularly women and youth, with the support of non-governmental organisations, in efforts to combat desertification and mitigate the effects of drought; and
- (e) provide an enabling environment by strengthening, as appropriate, relevant existing legislation and, where they do not exist, enacting new laws and establishing long-term policies and action programmes.
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ARTICLE 6: OBLIGATIONS OF DEVELOPED COUNTRY PARTIES

10. In addition to their general obligations pursuant to Article 4, developed country Parties undertake to:

- (a) actively support, as agreed, individually or jointly, the efforts of affected developing country Parties, particularly those in Africa, and the least developed countries, to combat desertification and mitigate the effects of drought;
- (b) provide substantial financial resources and other forms of support to assist affected developing country Parties, particularly those in Africa, effectively to develop and implement their own long-term plans and strategies to combat desertification and mitigate the effects of drought;
- (c) promote the mobilisation of new and additional funding pursuant to article 20, paragraph 2 (b);
- (d) encourage the mobilisation of funding from the private sector and other non-governmental sources; and

- (e) promote and facilitate access by affected country Parties, particularly affected developing country Parties, to appropriate technology, knowledge and know-how.

11. The full text of the Convention and updates on its current status can be found at the Internet World Wide Web Sites:

- http://www.unep.ch/incd.html.
- http://www.nasm.edu:1995/
- http://www.iisd.ca/linkages/desert.html

12. For further comments on implementation of the Convention see also: The Convention to Combat Desertification: Guidelines for NGO Activity by Camilla Toulmin. Drylands Programme Issue

APPENDIX 2: PROJECT COST TABLES

1. The Appendix contains the Summary Project Cost Tables as follows:

Table M2.1: Project Cost Summary

COMPONENTS	<----------JD '000---------->			<----------US$'000---------->			% Foreign	% Total
	Local	Foreign	Total	Local	Foreign	Total	Exchange	Base Costs
Pastoral Resources Information, Monitoring and Evaluation Unit	930.5	1,409.3	2,339.8	1,336.9	2,024.8	3,361.8	60%	63%
Range Assessment and Monitoring	197.3	208.8	406.1	283.5	300.0	583.5	51%	11%
Soil & Land Use Evaluation & Mapping	100.9	260.7	361.6	144.9	374.6	519.5	72%	10%
Livestock Related Studies	74.7	281.2	455.9	251.0	404.0	655.0	62%	12%
Institutional Support & Collaboration	100.1	53.0	153.0	143.8	76.1	219.8	35%	4%
TOTAL BASELINE COSTS	1,503.4	2,212.9	3,716.4	2,160.1	3,179.5	5,339.6	60%	100%
Physical Contingencies	55.2	62.6	117.8	79.3	90.0	169.3	53%	3%
Price Contingencies	196.7	263.3	459.9	282.6	378.3	660.8	57%	12%
TOTAL PROJECT COSTS	1,755.3	2,538.8	4,294.1	2,522.0	3,647.8	6,169.8	59%	116%

Table M2.2: Project Components by Year (JD'000)

COMPONENTS	JD'000 Base Costs					Total	
	PY1	PY2	PY3	PY4	PY5	JD'000	US$'000
Pastoral Resources Information, Monitoring and Evaluation Unit	788.6	532.9	566.0	226.1	226.1	2,339.8	3,361.8
Range Assessment and Monitoring	195.0	58.2	45.3	71.0	36.6	406.1	583.5
Soil & Land Use Evaluation & Mapping	106.3	119.6	69.9	49.1	16.7	361.6	519.5
Livestock Related Studies	281.9	174.0	0.0	0.0	0.0	455.9	655.0
Institutional Support & Collaboration	65.5	25.4	25.4	18.4	18.4	153.0	219.8
TOTAL BASELINE COSTS	1,437.2	910.1	706.6	364.6	297.9	3,716.4	5,339.6
Physical Contingencies	49.1	27.4	18.3	12.2	10.9	117.8	169.3
Price Contingencies	102.5	105.5	111.1	70.6	70.3	459.9	660.8
TOTAL PROJECT COSTS	1,588.8	1,042.9	836.0	447.3	379.1	4,294.1	6,169.8
Taxes	71.8	12.0	12.5	13.0	13.5	122.7	176.4
Foreign Exchange	1,047.4	669.2	517.3	185.3	119.6	2,538.8	3,647.8

Table M2.3: Project Components by Year (US$'000)

COMPONENTS	US$'000 Base Costs					Total	
	PY1	PY2	PY3	PY4	PY5	US$'000	JD'000
Pastoral Resources Information, Monitoring and Evaluation Unit	1,133.1	765.7	813.2	324.9	324.9	3,361.8	2,339.8
Range Assessment and Monitoring	280.2	83.6	65.1	102.0	52.6	583.5	406.1
Soil & Land Use Evaluation & Mapping	152.7	171.8	100.5	70.5	24.1	519.5	361.6
Livestock Related Studies	405.0	250.0	0.0	0.0	0.0	655.0	455.9
Institutional Support & Collaboration	94.0	36.4	36.4	26.4	26.4	219.8	153.0
TOTAL BASELINE COSTS	2,065.0	1,307.6	1,015.2	523.9	428.0	5,339.6	3,716.4
Physical Contingencies	70.5	39.4	26.3	17.5	15.7	169.3	117.8
Price Contingencies	147.3	151.5	159.6	101.4	101.0	660.8	459.9
TOTAL PROJECT COSTS	2,282.8	1,498.5	1,201.1	642.7	544.7	6,169.8	4,294.1
Taxes	103.2	17.2	18.0	18.7	19.4	176.5	122.7
Foreign Exchange	1,504.9	961.5	743.2	266.2	171.8	3,647.8	2,538.8

Table M2.4: Summary Accounts Cost Summary

	<----------JD'000---------->			<----------US$'000---------->			% Foreign	% Total
	Local	Foreign	Total	Local	Foreign	Total	Exchange	Base Costs
Investment Costs:-								
Vehicles	39.0	72.4	111.4	56.0	104.0	160.0	65%	3%
Office Furn & Equip	44.8	179.3	224.2	64.4	257.7	322.1	80%	6%
Technical Assistance	0.0	960.5	960.5	0.0	1,380.0	1,380.0	100%	26%
Training	121.4	359.9	481.2	174.4	517.1	691.4	75%	13%
Awareness Programmes	179.9	105.4	285.4	258.5	151.5	410.0	37%	8%
Special Studies	479.1	368.7	847.8	688.4	529.7	1,218.1	43%	23%
TOTAL INVESTMENT COSTS	864.2	2,046.2	2,910.4	1,241.6	2,940.0	4,181.6	70%	78%
Recurrent Costs:-								
Incremental Salaries	399.0	0.0	399.0	573.3	0.0	573.3	0%	11%
Field Allowances	47.2	0.0	47.2	67.9	0.0	67.9	0%	1%
Vehicle Operating	36.5	109.6	146.2	52.5	157.5	210.0	75%	4%
R&M Equipment	44.1	4.9	49.0	63.4	7.0	70.4	10%	1%
Computer Consumables	17.4	52.2	69.6	25.0	75.0	100.0	75%	59%
House Rents	60.1	0.0	60.1	86.4	0.0	86.4	0%	2%
General Operating	34.8	0.0	34.8	50.0	0.0	50.0	0%	1%
TOTAL RECURRENT COSTS	639.2	166.7	806.0	918.5	239.5	1,158.0	21%	22%
TOTAL BASELINE COSTS	1,503.4	2,212.9	3,716.4	2,160.1	3,179.5	5,339.6	60%	100%
Physical Contingencies	55.2	62.6	117.8	79.3	90.0	169.3	53%	3%
Price Contingencies	196.7	263.3	459.9	282.6	378.3	660.8	57%	12%
TOTAL PROJECT COSTS	1,755.3	2,538.8	4,294.1	2,522.0	3,647.8	6,169.8	59%	116%

Table M2.5: Summary Accounts by Year (JD'000)

	<----------Base Costs---------->						Foreign Exchange	
	PY1	PY2	PY3	PY4	PY5	Total	percent	amount
Investment Costs:-								
Vehicles	111.4	0.0	0.0	0.0	0.0	111.4	65%	72.4
Office Furniture & Equipt	219.7	1.1	1.1	1.1	1.1	224.2	80%	179.3
Technical Assistance	375.8	281.9	261.0	41.8	0.0	960.5	100%	960.5
Training	100.9	157.1	120.8	58.2	44.2	481.2	75%	359.9
Awareness Programmes	76.2	83.9	78.6	23.3	23.3	285.4	37%	105.4
Special Studies	393.7	214.4	73.4	88.6	77.6	847.8	43%	368.7
TOTAL INVESTMENT COSTS	1,277.8	738.4	534.9	213.0	146.3	2,910.4	70%	2,046.2
Recurrent Costs:-								
Incremental Salaries	79.8	79.8	79.8	79.8	79.8	399.0	0%	0.0
Field Allowances	9.4	9.4	9.4	9.4	9.4	47.2		
Vehicle Operating	29.2	29.2	29.2	29.2	29.2	146.2	75%	109.6
R&M Equipment	0.0	12.2	12.2	12.2	12.2	49.0	10%	4.9
Computer Consumables	13.9	13.9	13.9	13.9	13.9	69.6	75%	52.2
House Rents	20.0	20.0	20.0	0.0	0.0	60.1		
General Operating	7.0	7.0	7.0	7.0	7.0	34.8	0%	0.0
TOTAL RECURRENT COSTS	159.4	171.7	171.7	151.6	151.6	806.0	21%	166.7
TOTAL BASELINE COSTS	1,437.2	910.1	706.6	364.6	297.9	3,716.4	60%	2,212.9
Physical Contingencies	49.1	27.4	18.3	12.2	10.9	117.8	53%	62.6
Price Contingencies	102.5	105.5	111.1	70.6	70.3	459.9	57%	263.3
TOTAL PROJECT COST	1,588.8	1,042.9	836.0	447.3	379.1	4,294.1	59%	2,538.8
Taxes	71.8	12.0	12.5	13.0	13.5	122.7	0%	
Foreign Exchange	1,047.4	669.2	517.3	185.3	119.6	2,538.8	100%	2,538.8

Table M2.6: Summary Account by Project Component (JD'000)

	Pastoral Resource Information Monitoring and Evaluation Unit (PRIME)	Range Assessment and Monitoring	Soil and Land Use Evaluation and Mapping	Livestock Related Studies	Institutional Support and Collaboration	Total	Contingencies Physical %	Physical Amount	Price %	Price Amount
Investment Costs:-										
Vehicles	111.4					111.4	5%	5.6	8%	8.5
Office Furniture & Equip	164.3	9.0	10.8		40.1	224.2	5%	11.2	8%	17.3
Technical Assistance	689.0	125.3	146.2			960.5	0%	0.0	12%	111.4
Training	261.0	110.8	88.5		20.9	481.2	5%	24.1	15%	70.2
Awareness Programmes	285.4					285.4	5%	14.3	14%	39.9
Special Studies	114.8	160.9	116.1	455.9		847.8	5%	42.4	12%	98.8
TOTAL INVESTMENT COSTS	1625.9	406.1	361.6	455.9	61.0	2,910.4	3%	97.5	12%	346.1
Recurrent Costs:-										
Incremental Salaries	307.0				92.0	399.0		0.0	14%	55.7
Field Allowances	47.2					47.2	5%	2.4	15%	6.9
Vehicle Operating	146.2					146.2	5%	7.3	15%	21.4
R&M Equipment	49.0					49.0	5%	2.4	17%	8.3
Computer Consumables	69.6					69.6	5%	3.5	15%	10.2
House Rents	60.1					60.1	5%	3.0	10%	6.2
General Operating	34.8					34.8	5%	1.7	15%	5.1
TOTAL RECURRENT COSTS	713.9	0.0	0.0	0.0	92.0	806.0	3%	20.3	14%	113.9
TOTAL BASELINE COSTS	2339.8	406.1	361.6	455.9	153.0	3,716.4	3%	117.8	12%	459.9
Physical Contingencies	67.2	14.0	10.8	22.8	3.0	117.8				
Price Contingencies	303.9	49.1	46.3	42.2	18.5	459.9				
TOTAL PROJECT COST	2710.9	469.3	418.7	520.8	174.6	4,294.1				
Taxes	122.7	0.0	0.0	0.0	0.0	122.7				
Foreign Exchange	1620.3	236.1	300.5	321.4	60.6	2,538.8				

APPENDIX 3: LIST OF MISSION CONTACTS ESTABLISHED

NAME	POSITION	ORGANISATION	ADDRESS	PHONE	FAX
Mr Kalil Sobakei	Reporter	Al Rai newspaper	P.O. Box 6710, Amman	667171	661244
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Ms Karen Jones	Vet	Badia Research and Development Programme, Safawi	Safawi	885164/885186	
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Mr Mohammed Shabaz	Director,	Badia Research and Development Programme, Higher Council for Science and Technology		830301	830589
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Eng. Mohammed B. Al Zuheir		Beni Sakher	P.O. Box 59, Shaab, Jordan	723135	
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Dr Roderick Dutton	Director	Centre for Overseas Research and Development	Science Laboratories, South Road, Durham, UK	0191 3742494	0191 3742495
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Mr Mohammed N. Ateyh	Plant Protection, Environmental Section	Department of Statistics, Ministry of Planning		842171	
Mr Monther Dawud	Microbiologist, Environmental Section	Department of Statistics, Ministry of Planning		842171	
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List Of Mission Contacts Established (cont.)

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Dr Amir Salman	Agricultural Economics and Extension	Faculty of Agriculture, University of Jordan	University of Jordan, Amman	843555	832318
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Mr Mohammad Sameh	GIS specialist	Soil Survey Division, Department of Forestry and Range, Ministry of Agriculture	P.O. Box 961034Amman	842751/2	
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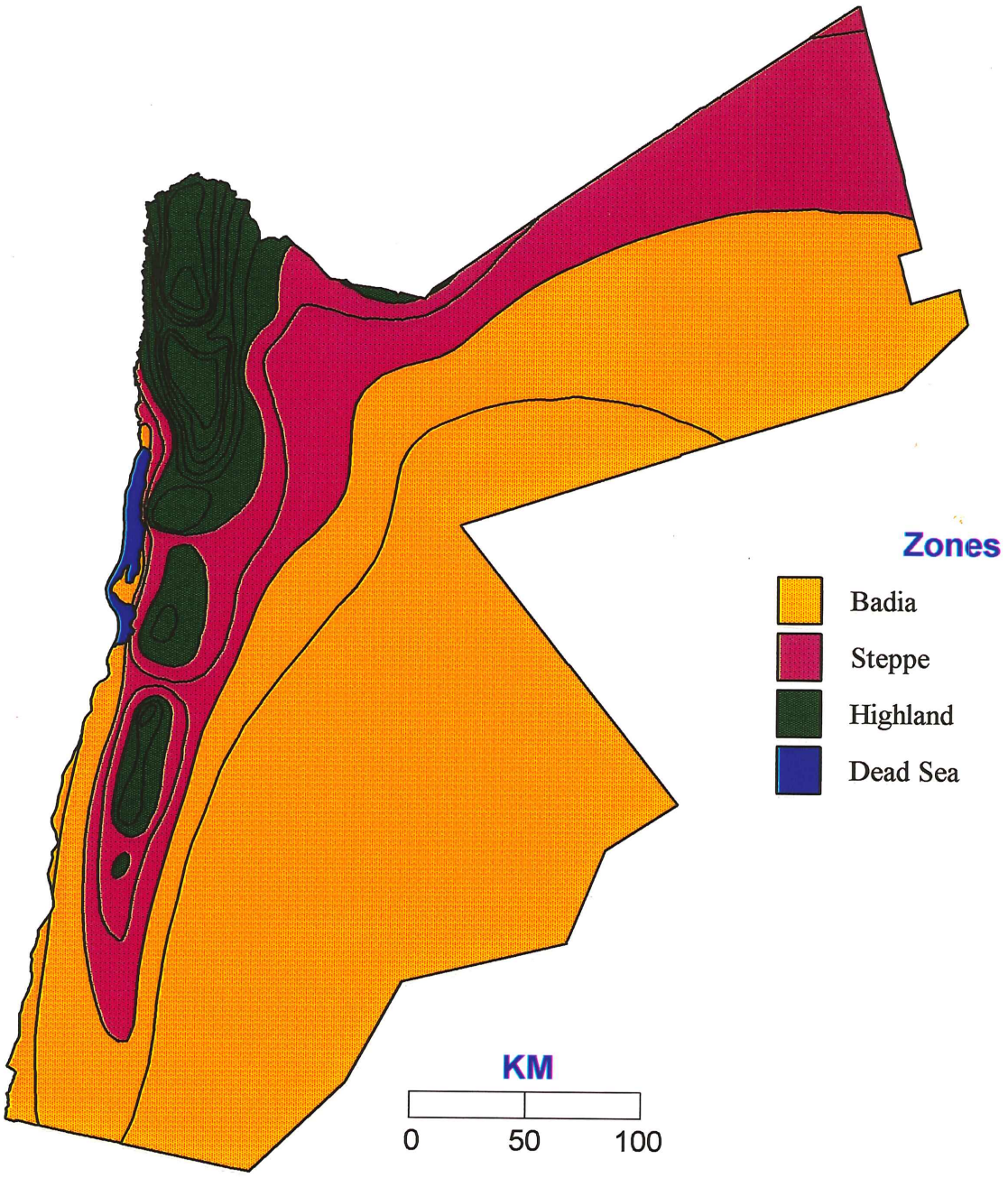
Mr Humam Mufti		Special Technical Services	7th Circle, Shabon Bldg, P.O. Box 950745, Amman 11195	827502	829213
Mr Antoine Swenne	Dana Reserve Survey, RSCN				
Mr Luis Garcia	USAID, TA to DOS	U.S. Bureau of the Census	Washington DC 202333-3102	00 1 301 457 1453	00 1 301 457 3033
Mr Firas F. Gharaibeh	Senior Programme Assistant	UNDP	P.O. Box 35286, Amman	668171-7	676582
Dr Cherie Lenzen	Advisor	USAID, Jordan	c/o US Embassy, 2nd Circle, Jebel Amman		
Mr Mustapha Miled	Country Director	World Food Programme	P.O. Box 35286, Amman	668171/4	601496

APPENDIX 4: COLOUR MAPS

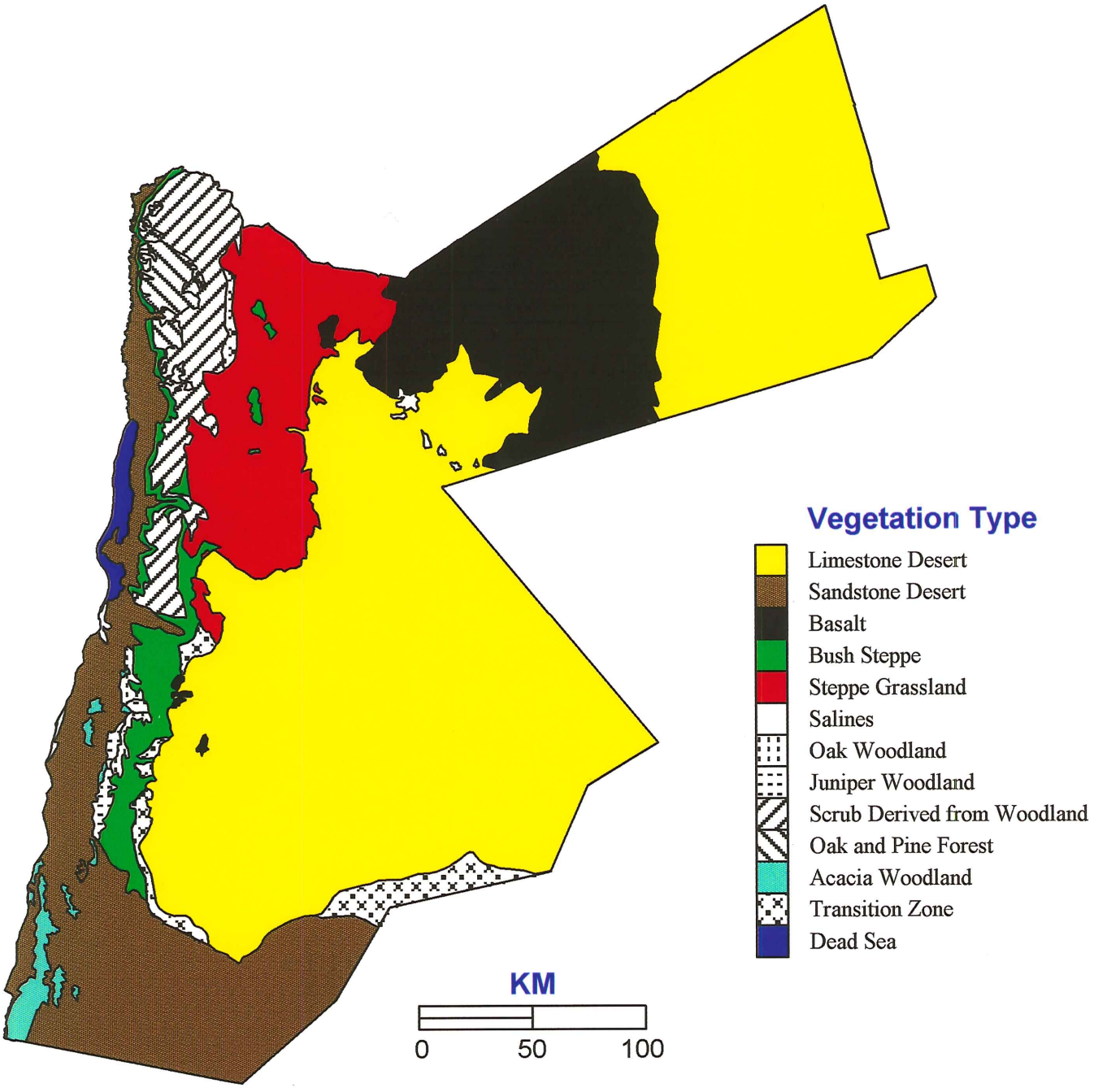
Monochrome versions of the maps listed below are presented for reference in the appropriate Annexes.

Map 1: Agro-climatic Zones



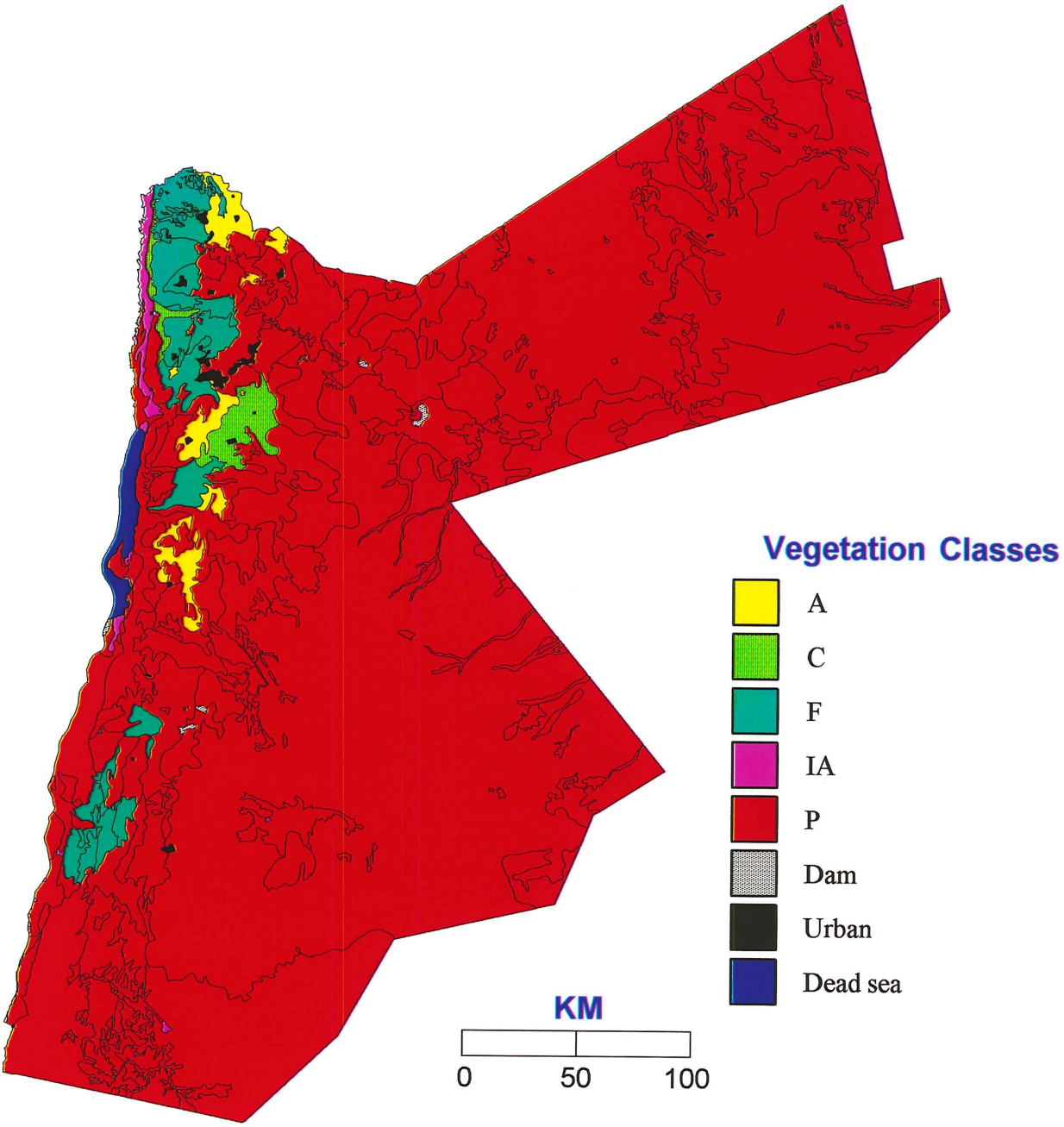
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 2: Huntings 1956 Vegetation Categories



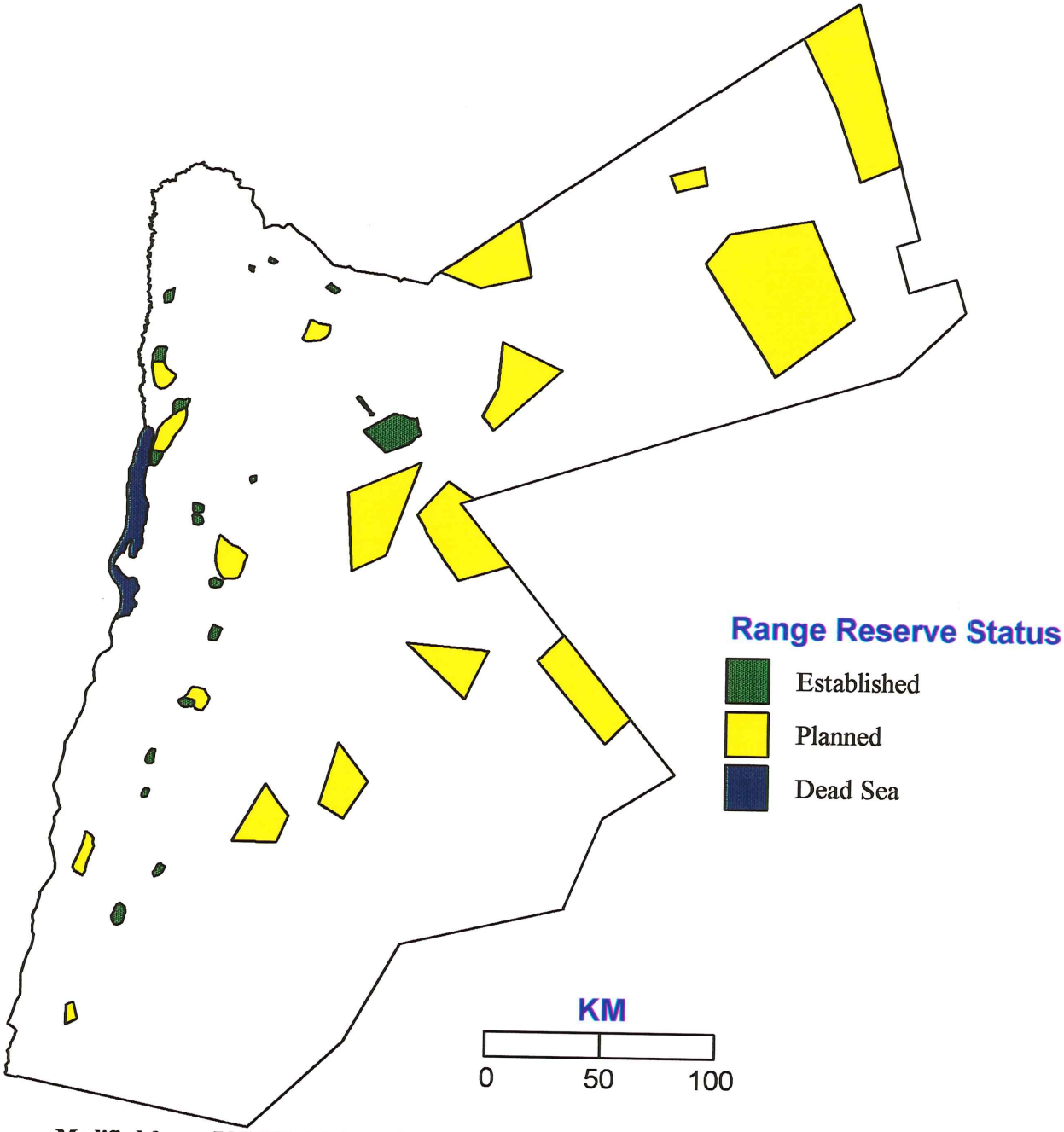
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 3: FAO (1991) Plant Associations



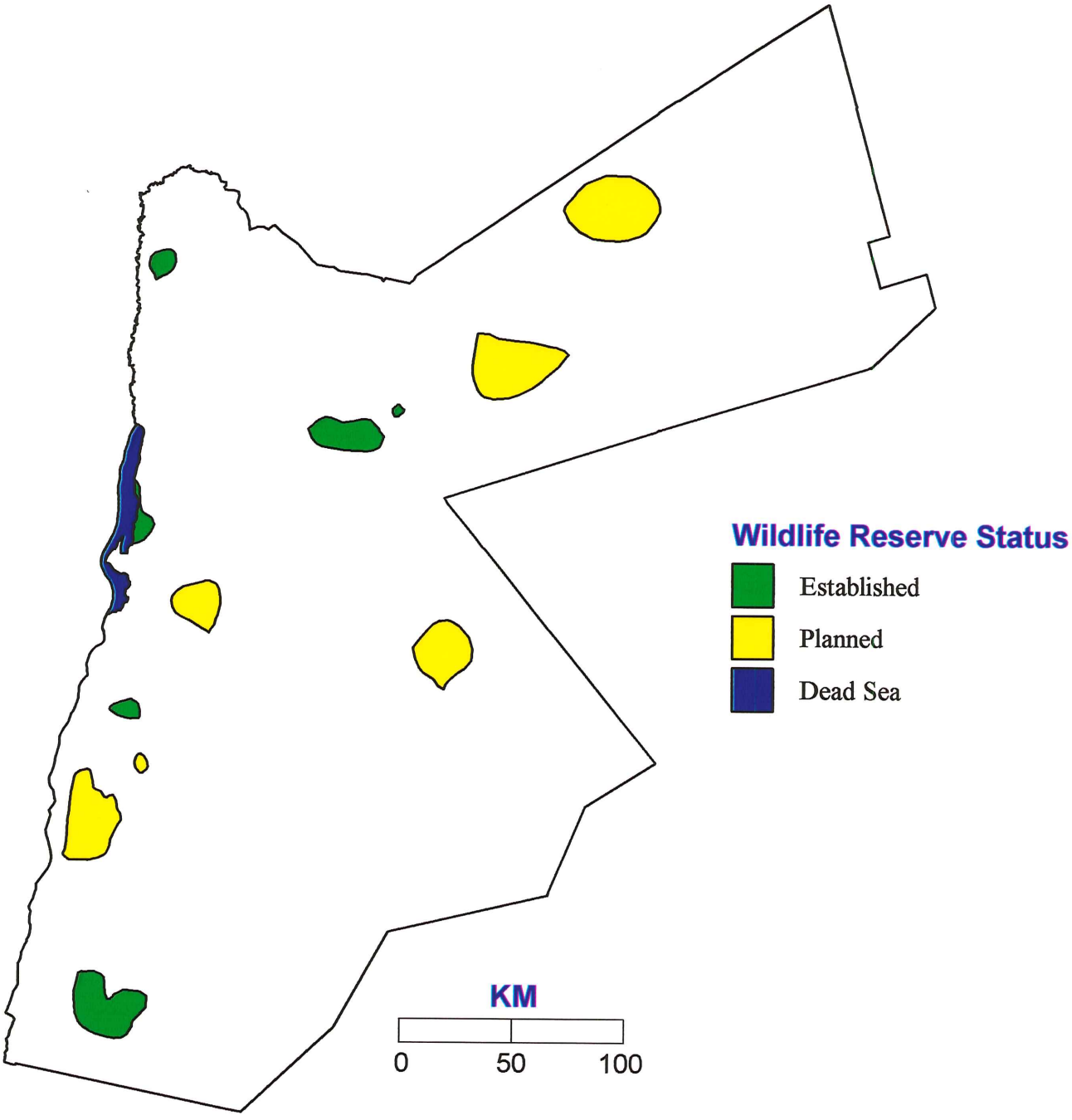
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 4: Rangeland Reserves



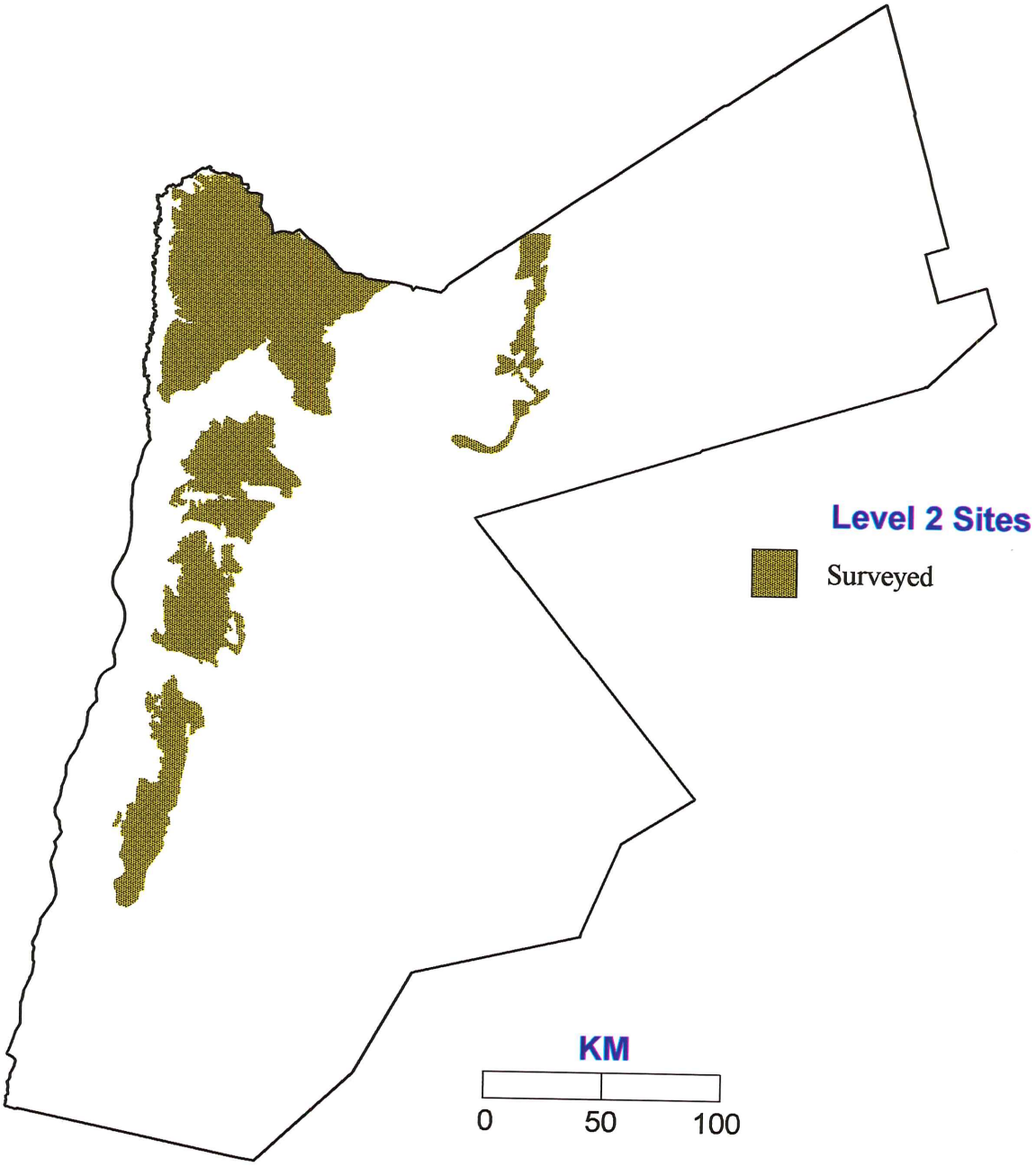
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 5: Wildlife Reserves



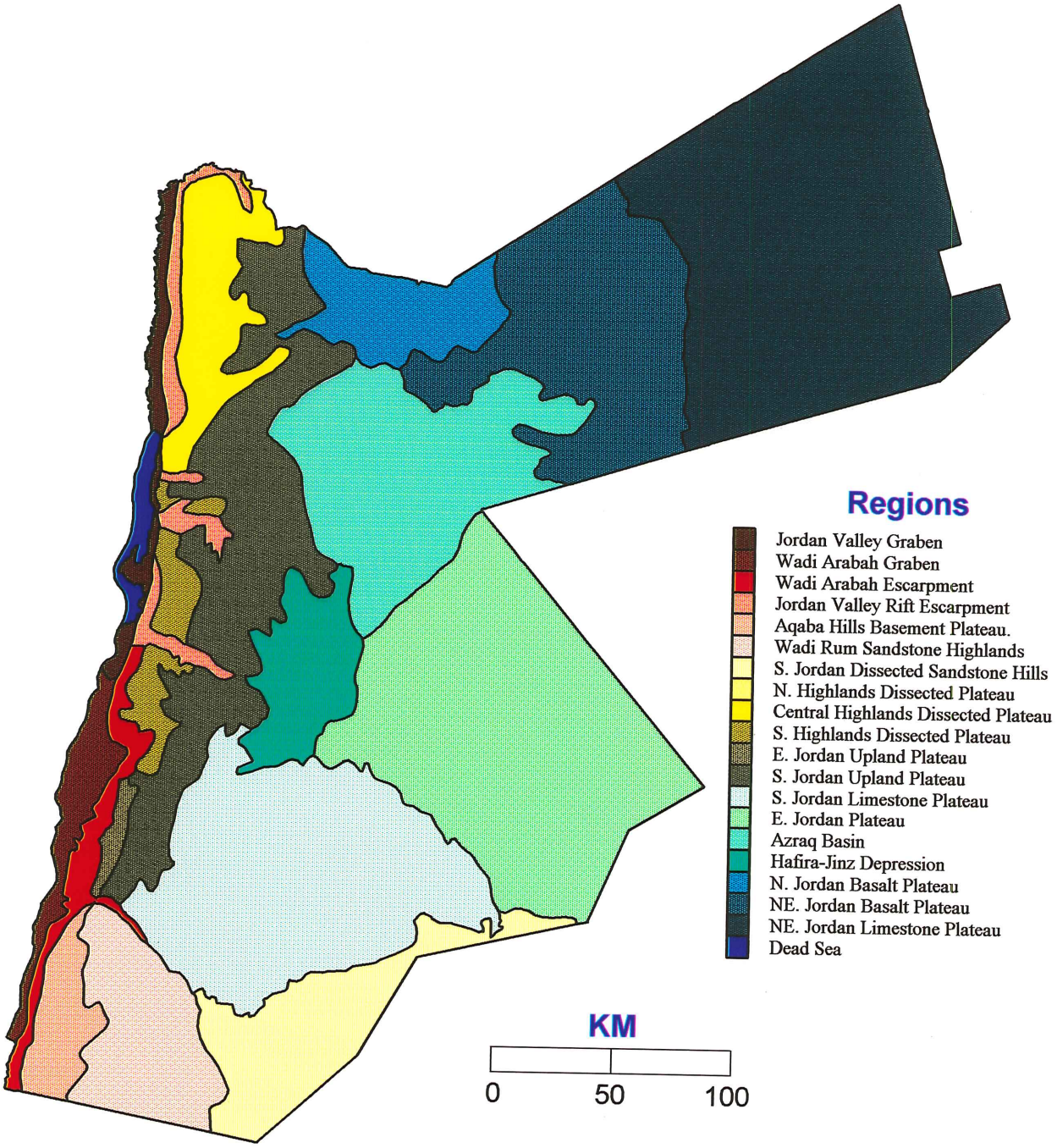
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 6: Level 2 Soils Survey Study Areas



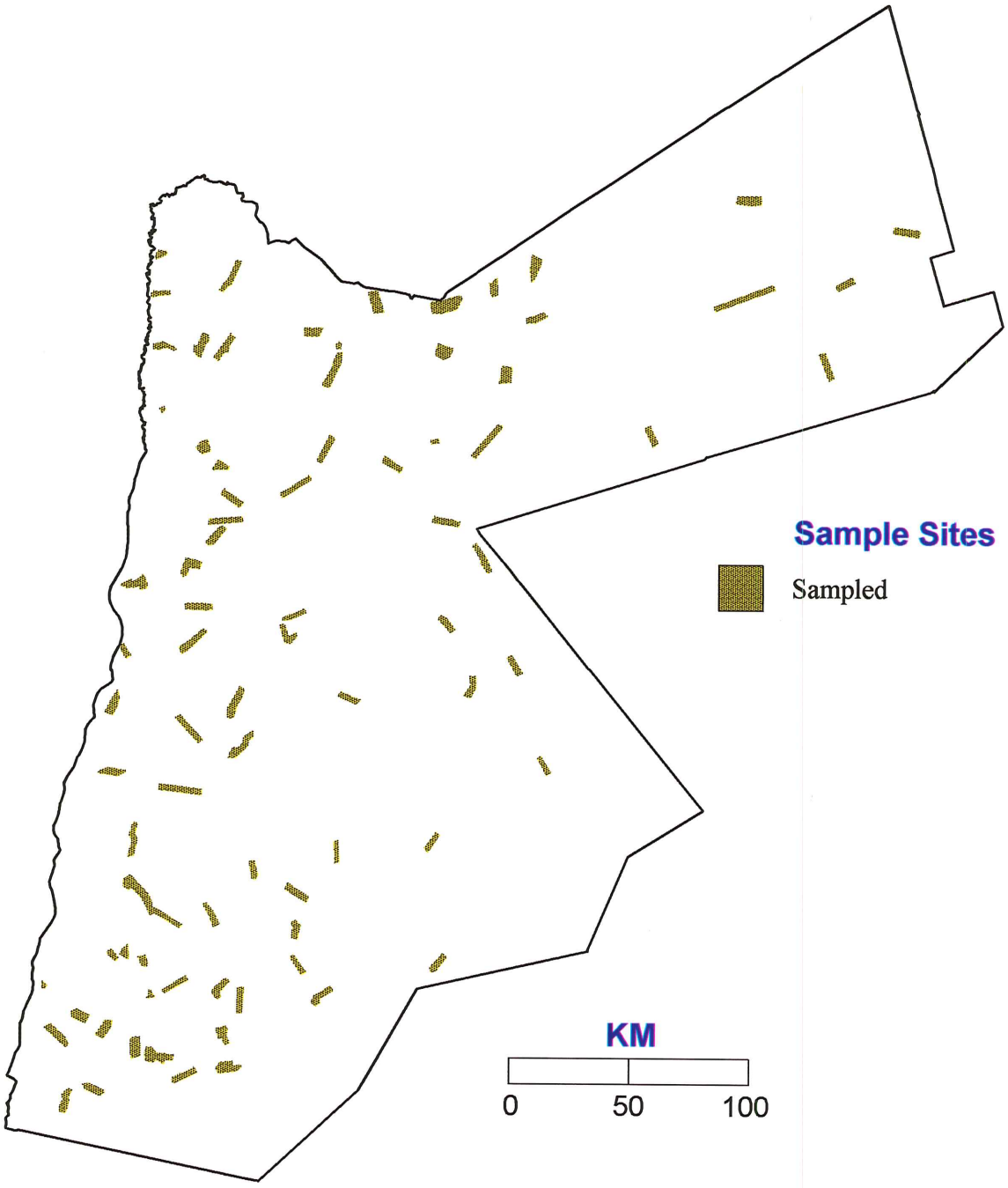
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 7: Physiographic Land Regions



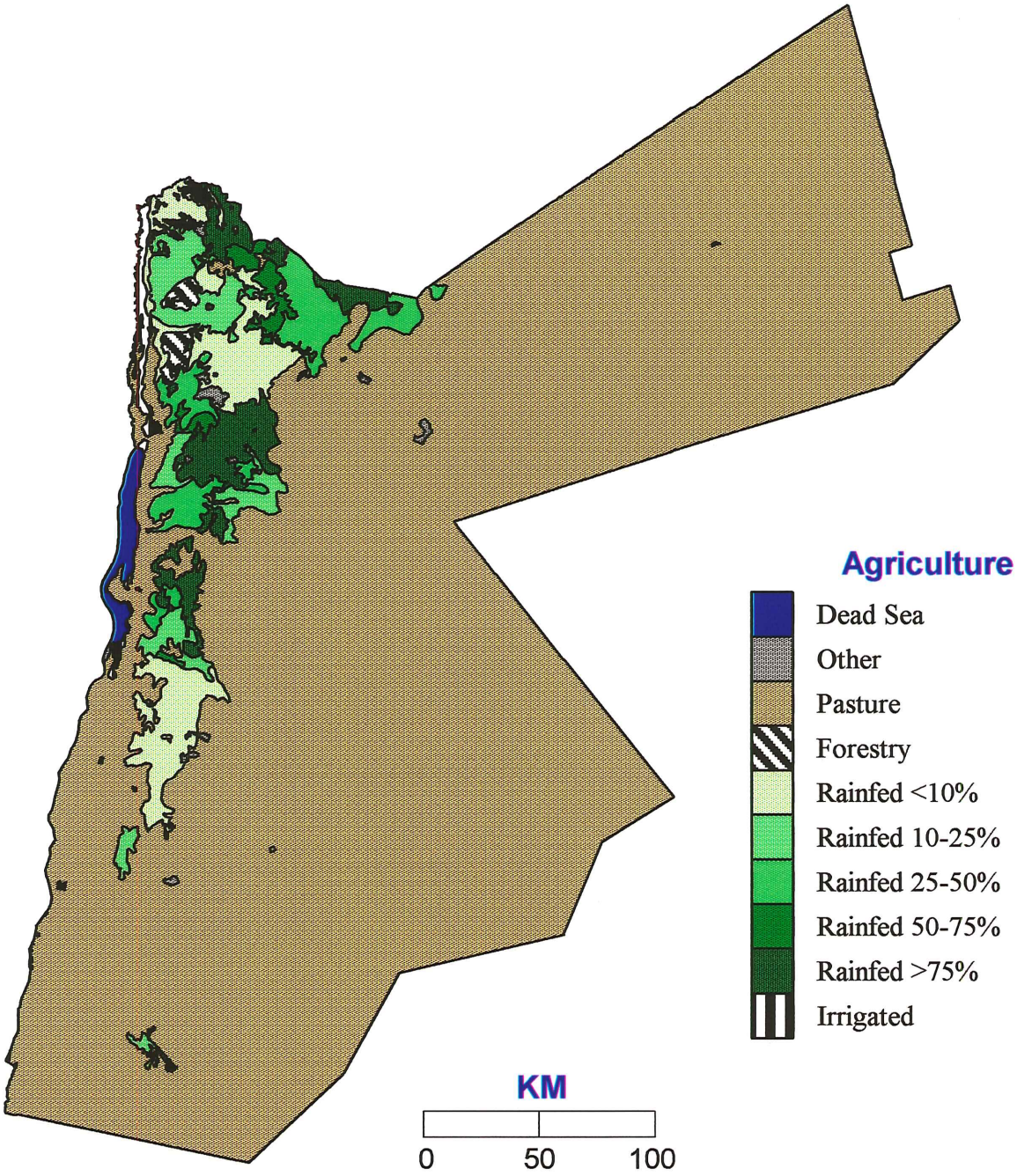
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 8: Level 1 Soil Survey Sample Areas



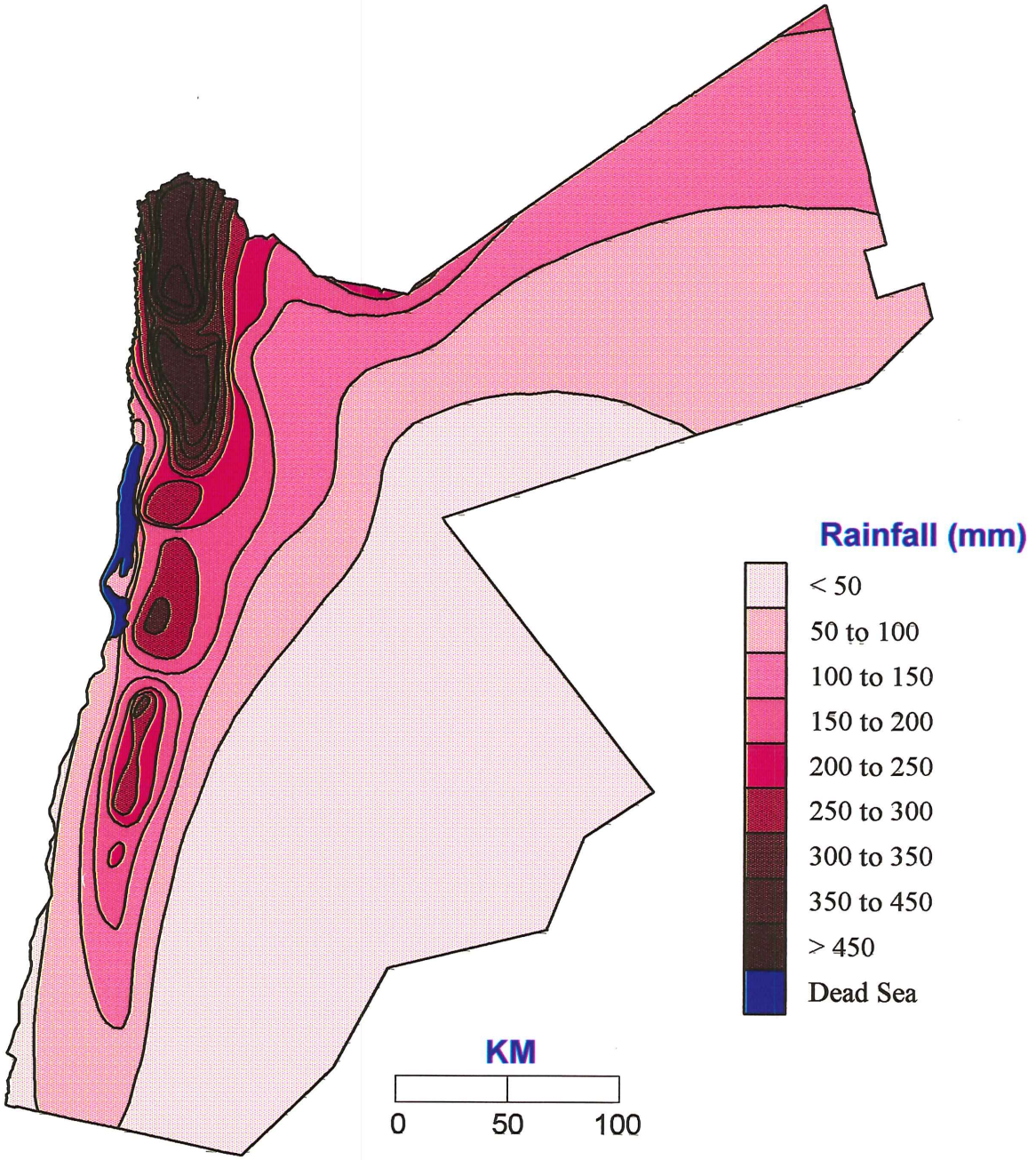
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Map 9: Agricultural Land Use



Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

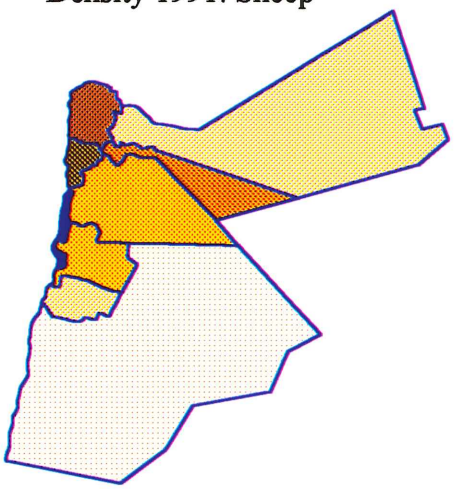
Map 10: Annual Precipitation

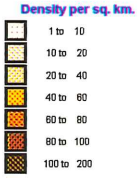


Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

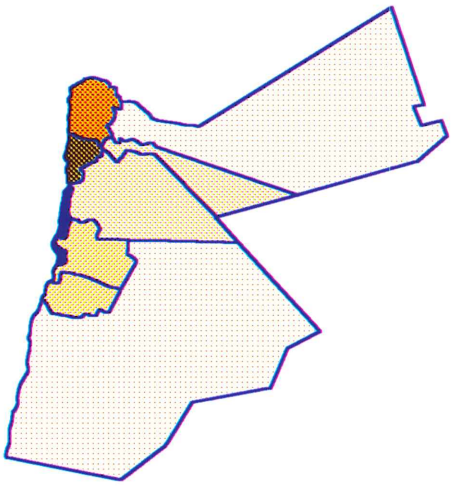
Map 11: Sheep and Goat Densities 1991 and 1993

Density 1991: Sheep

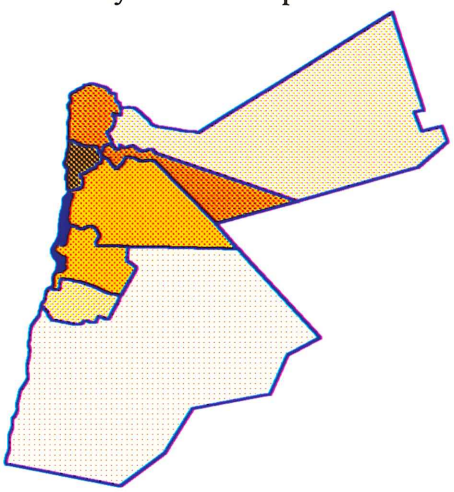


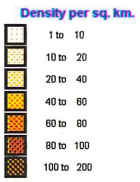


Density 1991: Goats

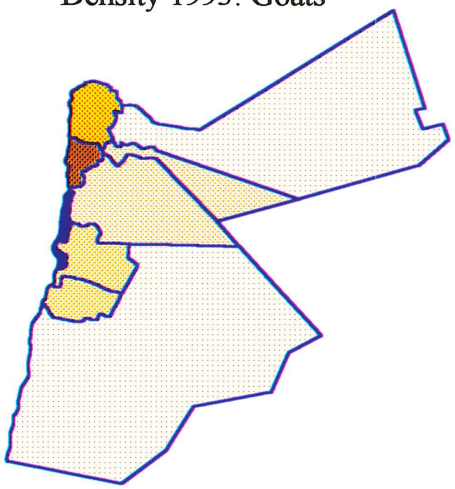


Density 1993: Sheep

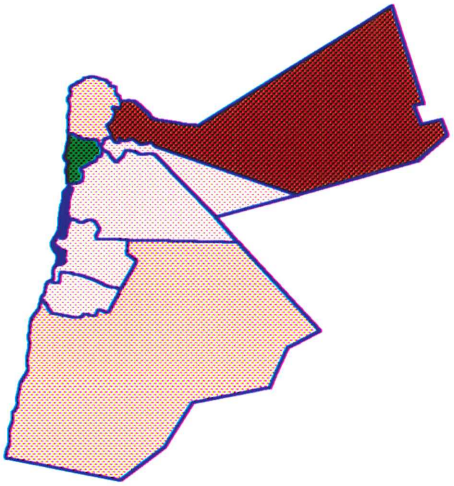


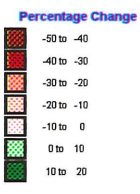


Density 1993: Goats

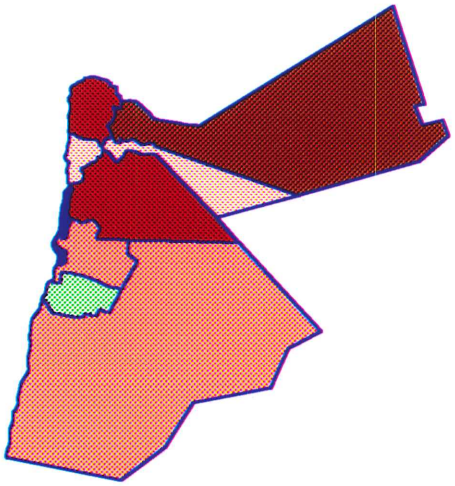


Percentage Change: Sheep





Percentage Change: Goats



The Hashemite Kingdom of Jordan

National Programme for Range Rehabilitation and Development

Pastoral Resources Assessment, Monitoring and

Co-Ordinating Project

ANNEX 1: INSTITUTIONAL AND SOCIO-ECONOMIC MATTERS

TABLE OF CONTENTS

INTRODUCTION

1. Building on recommendations for the establishment of a Jordanian National Range Rehabilitation and Development Programme (IFAD, 1993), a follow-up Mission was mounted to design the Pastoral Resources Assessment and Monitoring Component of the Programme. The Mission's objectives were: (1) to identify and evaluate information concerning pastoral rangeland and livestock related resources in Jordan, and to assess specific areas, where relevant data are inadequate, or unreliable; and (2) to evaluate resource assessment and monitoring requirements, and identify priorities for institutional strengthening.

2. The Main Report of the Mission describes a technical assistance project for the management and co-ordination of proposed activities, to be implemented by a semi-autonomous Pastoral Resources Information and Monitoring and Evaluation Unit (PRIME), specifically set up for the purpose.

3. This Annex considers various institutional matters and was prepared by the Institutional Strengthening and Capacity Building Specialist whose responsibilities included:

- Assessing current institutional capabilities and identifying support and capacity building requirements;
- Specifying appropriate institutional frameworks, linkages and backstopping arrangements;
- Identifying current capabilities for the assessment and monitoring of livestock market prices and terms of trade, and of the levels of imported foodstuffs and supplementary feeds;
- Ensuring that the recommendations of the recent IFAD socio-economic monitoring assessment study are incorporated within the Project's design.

4. Available information and facilities relating to institutional capabilities are reviewed, and details of PRIME's proposed structural framework and functional linkages are presented here. Institutional co-ordination and technical backstopping arrangements are stressed. Socio-economic and awareness aspects of the proposed Project are also considered.

5. Information pertaining to livestock marketing, feed prices and terms of trade has, for the sake of logical consistency, been incorporated in Annex 4, which focuses specifically on Livestock.

6. During the course of the Mission, discussions were held with a variety of people, representing a wide range of organisations, including the following:

- Ministry of Agriculture: Department of Forestry and Range (Range Division, and Soils and Land Use Division); Department of Agricultural Policy and Economics; Department of Projects; Department of Agricultural Extension and Information; National Centre for Agricultural Research and Technology Transfer;
- Jordan Co-operative Organisation;
- Ministry of Planning;
- Department of Statistics;
- Department of Lands and Survey;
- Royal Jordanian Geographic Centre;

- Higher Council for Science and Technology:
- Jordan Badia Research and Development Programme;
- National Information Centre;
- Royal Society for the Conservation of Nature;
- University of Jordan, Arid and Semi-Arid Zones Project;
- Queen Alia Fund;
- Noor Al Hussein Foundation;
- EU; GTZ; ICARDA; UNDP; UK ODA; and USAID

INSTITUTIONAL FRAMEWORK: THE MINISTRY OF AGRICULTURE AND THE NATIONAL AGRICULTURAL POLICY CHARTER

7. Structural adjustment of the agricultural sector and reorganisation of the Ministry of Agriculture in Jordan have been subjects of discussion for a number of years. Agricultural sector reform has been the specific focus of attention of an Institutional Development Support Project for Agricultural Policy Implementation, supported by GTZ and USAID. Various studies have been commissioned by the project and The World Bank, including: Coopers and Lybrand (1993) on Institutional Issues; MMIS (1994) on Institutional Implications of Agricultural Policy Implementation; ERMC et al. (1994) on Environmental Implications; Mutius (1995) on Organisational Development.

8. An Agricultural Sectoral Adjustment Loan became effective in early 1995, with The World Bank leading a consortium of agencies, including the IMF and various bilateral sources.

9. At the time of the Mission's visit, the Ministry of Agriculture had 14 separate Departments and 22 Regional Directorates, reporting through three Assistant Secretary Generals and a Secretary General with six independent Advisers, to the Minister of Agriculture, who in turn received advice and recommendations from: the Agricultural Council, the National Centre for Agricultural Research and Technology Transfer, a Projects Steering Committee and a Planning Committee.

10. Although there is an inevitable resistance to change in certain quarters, it is widely perceived that the present structure of the Ministry is unwieldy, and that further streamlining is required to transform it into a more responsive and effective organisation. It is understood that the main changes under review include a substantial reduction in manpower, and increasing privatisation of erstwhile goverment implementaion activities. In order to achieve this goal it is essential that a set of sound guiding principles and priority objectives are established. It is to this end that a Draft Agricultural Policy Charter has been under consideration since 1993.

11. The Agricultural Policy Charter (Ministry of Agriculture, 1995) has recently been endorsed by the Agricultural Council and has been presented to Cabinet for approval. The Charter sets out the objectives of Agricultural Policy in Jordan; the Institutional and Infrastructural Support Requirements; and details policies and strategies for Irrigated Agriculture; Rainfed Agriculture; Low Rainfall Zones; Integrated Livestock Production; and Forestry.

12. The broad agricultural policy objectives for the low rainfall zone may be summarised as follows:

- Prevention of rangeland degradation and reversal of the desertification process;
- Restoration of rangeland productivity and stabilisation of range forage and livestock production;
- Enhancement of environmental quality; and
- Improvement of the economic and social welfare of inhabitants of these rangeland areas who are dependant on them for their livelihood.

13. The Charter recognises that, in order to achieve these objectives, it is imperative to develop and implement policies to address the existing problems of land use, economic and social development, management and administration. It is recognised that it will be necessary to modify the roles of Government agencies involved and their current responsibilities. It is also essential to create a cadre of qualified and experienced range managers, scientists and administrators required for effective rangeland policy implementation.

14. The strategy for promotion of integrated livestock production focuses on the substitution of imported red meat, peri-urban dairying, and intensive poultry meat and egg production. Overall livestock policy objectives are to optimise livestock production, processing and marketing; and the optimisation of feed production. These are to be achieved through increased output of potential feeds, including utilisation of agricultural by-products; improved feeding and animal husbandry techniques; better health care; and increased efficiency of processing and marketing of livestock products.

15. It is within the overall framework of the new Agricultural Policy Charter that the present project has been specifically formulated to address a key area of reform: the development of policies and strategies for sustained exploitation of Jordan's low rainfall zones. The project is also likely to impinge on policy issues relating to the integration and intensification of livestock production - in particular, destocking and the supply of lambs and kids for fattening on commercial feedlots.

PASTORAL RESOURCES INFORMATION MONITORING AND EVALUATION UNIT

FUNCTIONS

16. There is a wealth of data and skills already available in Jordan, so much of the information and expertise required for an effective assessment of pastoral resources is already available. It is, however, dispersed amongst a wide range of government and other institutions, and there is currently little co-ordination, or exchange of information between the various organisations.

17. It is therefore proposed that a special Unit be established for Pastoral Resource Information, Monitoring and Evaluation (PRIME). The Unit would be responsible for collecting, collating, and integrating all information relating to rangelands, livestock, and land-use currently available in Jordan. This would be undertaken through formal collaborative agreements within government and other institutions.

18. Where necessary, ancillary studies would be commissioned to fill information gaps, and obtain additional information, as required. Supervision, equipment and training would be provided, where needed. In order to minimise start-up costs, such studies would be achieved through building on planned or existing projects, where practical, and by strengthening or expanding existing national capabilities.

19. The success of this strategy would very much depend on effective collaboration between the Unit and the institutions and agencies with data currently available, and with those commissioned to carry out additional studies. One of the Unit's most important initial tasks would therefore be to establish links with relevant institutions. These would include a number of government Departments as well as non-governmental institutions. All those approached during the course of the Mission indicated their willingness to co-operate, and a number offered assistance, either by making facilities and logistic support available at no cost, or on a cost recovery basis. It is recommended, however, that full implementation of the Unit be made conditional upon the establishment of formal agreements for collaborative study and the exchange data.

20. All collaborating bodies would be strongly encouraged to participate in the analytical and interpretative stages of this process and would be given access to the results. Planners and decision makers would also be kept closely informed of the Unit's work.

21. In the first instance, PRIME's roles would be to: provide a national focal point for range resource assessment; facilitate the collection of reliable and up to date information; standardise procedures for processing, analysis and storage of data; and establish a sound baseline for long term monitoring and policy analysis.

22. Once properly established, PRIME would then be in a position to take on additional responsibilities, including the targeting of potential interventions for the Range Rehabilitation and Development Programme, and the identification of alternative options. Close co-operation with implementing agencies and collaborating institutions would be required to: ensure that database structure was suitable for analyses; prioritise interpretative procedures to meet implementation needs; and provide appropriate products in a timely and efficient manner.

23. Whilst PRIME would act as the central focal point for range resource assessment, it would rely largely on external organisations for the gathering of additional information. These studies would be commissioned either, according to terms of reference proposed by the present Mission (see Annexes), or as in due course determined by PRIME itself. Strict guarantees of performance would be defined in the terms and conditions of these sub-contracted studies.

24. The Unit would be responsible for ensuring provision of adequate technical assistance as and when required, either from its own resources, or by identifying and recruiting suitable short to medium term assistance from within, or outside Jordan. The Unit would also be responsible for the provision of some logistic support by, for example, assigning vehicles from its own pool for short-term field work, and for providing specialised equipment where required.

25. It is envisaged that the Unit would have assembled sufficient information to be able to produce useful output within 18 months of start-up. During this initial period, the Unit would have carried out a baseline pastoral resource assessment from a national perspective, which would subsequently be updated on a regular, but less intensive basis.

26. Once the initial pastoral resource assessment had been achieved, PRIME's subsequent activities would be directed at: refining the primary database; building national capacity to ensure sustainability of the Unit; and conducting more detailed studies associated with specific local interventions.

27. PRIME would also commission a series of socio-economic surveys to be implemented by collaborating institutions and consultants, and oversee the collation and analysis of information obtained from such studies. The objective being to identify those elements of the rural population most susceptible to the impact of rangeland degradation; defining their geographical locations; and thus providing an objective basis for targeting inputs and activities for poverty alleviation.

28. Awareness building and the promotion of pastoral participation is considered to be one of the key functions of the Unit. To this end, PRIME would design and supervise implementation of a national awareness programme to: raise the profile of rangelands and arid land development, both amongst pastoralists, themselves, and the wider general public; identify and focus in on the problems that need to be addressed; and highlight the consequences of neglect and misuse.

29. The Unit would establish appropriate mechanisms for informing public opinion, and creating an effective dialogue with pastoralists in urban, peri-urban and rural areas, including use of national media, network newsletters, discussion fora and audio-visual presentations. In addition, existing dissemination networks would be used wherever possible.

30. The results of technical analysis and interpretation are, however, rarely suited to public consumption, and need to be adapted and translated into a more digestible form if they are to be disseminated outside technical circles. PRIME would, therefore, be required to produce material in a form suitable for mass circulation to the population at large, as well as pastoralists and their representatives, and other organisations with established links to target populations. This would involve close collaboration with the media and other dissemination networks.

INSTITUTIONAL LINKAGES AND MODALITIES FOR USE OF PROJECT OUTPUT

31. It is envisaged that the proposed Project will be implemented through the Ministry of Agriculture. However, the Agricultural Council has only very recently approved a new Agricultural Policy Charter, and it is understood that this may well entail some restructuring of the Ministry and reallocation of functions. It is not yet clear what form this restructuring will take, so recommending specific attachment for the PRIME co-ordinating unit within the Ministry at this stage in proceedings is somewhat problematic.

32. Ideally, to have maximum impact, the proposed Project would need to be attached at a high level within the Ministry, perhaps to the Secretary General's Office, or directly to the Agricultural Council. Alternatively, it might be attached to the Department of Agricultural Policy and Economics or the Department of Forestry and Range within the Ministry. However, because of the close collaboration envisaged between PRIME and the Soil Survey and Land Use Division, it would seem sensible, for logistic reasons, for the proposed project to be physically located at the Department of Forestry and Range Headquarters site at Kamalia on the outskirts of Amman.

33. Given the wide-ranging co-ordinating role of the proposed Project, and the need for establishment of an extensive network of contacts, both within and outside Government, it is envisaged that the Project would require the support of an influential steering committee representing the main collaborating institutions, to include representatives of: the Ministry of Agriculture; Department of Lands and Survey; Jordanian Co-operative Organisation; Department of Statistics, Ministry of Planning; Meteorological Department; Higher Council for Science and Technology; Royal Jordanian Geographic Centre; Queen Alia Fund; and University of Jordan's Faculty of Agriculture.

34. In order to ensure the smooth execution of the proposed Project, particularly the identification and commissioning of the necessary studies, the unit would require substantial financial and institutional autonomy. This may include the payment of non-standard salaries and expenses to PRIME staff in order to ensure their whole hearted involvement with the Project.

35. A detailed work programme would be prepared each year, which would set specific targets to be achieved within defined time periods. Studies undertaken on behalf of the project by collaborating organisations would be subject to contractual agreements specifying respective inputs, anticipated outputs and time-frames.

36. An annual project report would be prepared and circulated amongst collaborating organisations and other interested parties. This report would include a section providing a general overview of the status of range and pastoral resources. In due course, it is envisaged that this section could be expanded and published separately as an annual 'State of the Rangelands' report.

37. Modalities for the utilisation of project outputs would be through direct and indirect influence on formulation and implementation of agricultural and environmental policy, relating to the sustainable development of dryland areas. Direct influence on policy issues would be via, reports and recommendations targeted at advisers, policy makers and decision takers in Government, particularly the Department of Policy and Agricultural Economics, the Agricultural Council, the Secretary General, the Minister and Cabinet. Direct influence on implementation would come with the formal establishment of the Rangeland Rehabilitation and Development Programme. The cadre of trained and experienced pastoral resource assessment and range management personnel would also be substantially increased.

38. Indirect influence would be achieved through various means, including media coverage and heightened awareness of the general status of Jordanian rangelands, both within Government and amongst the public at large. A network of communications with pastoralist and rural communities would be fostered through non-governmental organisations, traditional leaders and other semi-official and official channels, to sound out opinion on complex issues involved in pastoral resource management and obtain feedback on options available for future development.

STAFFING REQUIREMENTS

39. The PRIME co-ordination unit would operate as a compact, tight-knit group of high grade well motivated staff, headed by a Senior Jordanian Project Manager, supported by Technical Assistance staff and short-term, back-up consultants, of both national and international origin.

40. Specifically, there would be a Project Manager (PM), with a doctorate or equivalent postgraduate qualification and at least 15 years experience in the field of agricultural development or environmental management. The PM would initially be responsible for setting up the Unit, and thereafter for its overall performance and smooth operation, and ensuring the successful co-operation of the collaborating institutions. The PM would also be the de-facto administrator of the Project.

41. In addition there would be three M.Sc. grade and two B.Sc. grade local staff:

- Socio-economist, whose primary role would be the co-ordination and implementation of the awareness programmes and socio-economic surveys;
- Senior Monitoring and Evaluation Officer, who would be responsible for the more technical aspects of data collation and analysis, and who would ensure the statistical validity of the field data collection programmes, and the compatibility of the various data types obtained;
- Range Management Officer, with responsibility for organising and supervising the collection of field data defined in the Range and Soils Study Sub-Components; and
- two Junior Monitoring and Evaluation Officers, assigned to assist the Senior M&E Officer in computer operation and processing of field data. These Officers may also be seconded to collaborators for short periods to assist with preliminary data processing.

42. Before their appointment, it should be made clear to all senior staff that, subject to the provision of suitable allowances, they should be prepared to make extended visits to the field, and should not expect to spend the majority of their time in the Amman office. This should be stipulated in their employment contracts. Salary and allowance levels may well have to be enhanced in order to provide realistic and effective inducements, and ensure adequate motivation.

43. It is envisaged that there would be four Diploma standard Computer Operators, who would process incoming field data forms, and carry out the primary data entry procedures. These personnel should have at least two years experience of computer data processing, and be sufficiently familiar with agricultural or environmental information to be able to screen incoming data for obvious errors and omissions. Their day to day activities would be organised and supervised by the senior staff.

44. Other supporting staff would include a secretary to assist with administrative paperwork, and drivers.

45. Technical Assistance would be provided in the form of two full time professional officers - an environmental specialist to work with the Range Management Officer, and an information/image processing specialist to work alongside the Senior Monitoring and Evaluation Officer. Each would be responsible for identifying the initial guidelines and subsequent work programmes for their counterparts, and for providing 'on the job training' to ensure continuity of project activities after their departure.

46. PRIME's analysis and interpretation must be placed in an appropriate economic context. A consultant environmental economist would, therefore, be retained to review PRIME's work

plans and findings, on a twice yearly basis; advise on economic and socio-economic considerations; and strengthen arguments for sustainable use of range resources.

47. Significant levels short-term technical assistance would also be required, both to provide specialist training in the use of GIS and remote sensing software to PRIME staff, and some of the collaborating institutions, particularly in the initial phases of the Project. Training in these areas is available from RJGC, and so could be provided locally.

OUTLINE JOB DESCRIPTIONS

48. It has been assumed that office accommodation would have been identified and assigned before the Project implementation, and that the institutional framework for PRIME's activities would have been agreed during prior negotiation between funding agencies and Government.

49. The following outline Job Descriptions summarise the essential tasks of the senior project staff members. It is assumed that the usual preamble describing PRIME's brief and giving details of the proposed work programme (derived from the Main Report) would be incorporated into each, but has not been included here.

50. The preliminary start-up and establishment phase of the project would greatly benefit from the early secondment of counterparts and appointment of local staff, as well as brief inputs from short-term Technical Assistance personnel.

Project Manager

Qualifications and Experience Required

51. The applicant should have a PhD or equivalent and at least 15 years experience in agricultural development or environmental management, as well as 5 years experience in project management and administration. Some knowledge of the socio-economic and environmental economic aspects of dryland agriculture and pastoral systems is required, and computer literacy to an advanced level, as well as familiarity with Windows software is essential.

52. The applicant should also be familiar with the operating principles of remote sensing and GIS use, and have a thorough grounding in quantitative analysis and interpretation.

Tasks

53. The appointee would initially be responsible for setting up the basic infrastructure of the Unit, appointing staff members, and setting in train the procedures required to purchase and, if necessary, import the Unit's equipment and vehicles.

54. High priority should also be given to setting up collaborative and data exchange agreements with co-operating institutions (MoA, DoS, Met Department, RJGC, HCST (NIC and BRDP), Queen Alia Foundation, RSCN, JCO, UoJ). The timely implementation of the Institutional Support and Collaboration Sub-Component would be an important aspect of this task.

55. *Note:* The successful outcome of the Project would depend on these agreements, and it may be desirable to make the appointment of PM permanent only on the condition that the agreements are in place within a fixed period - perhaps six months.

56. The appointee would also ensure that suitable reporting and liaison mechanisms between PRIME, MoA, and the project's Steering Committee, were put in place early in the Unit's life, and were subsequently adhered to.

57. Once PRIME becomes operational, the appointee would be responsible for over-seeing and administering the Unit's budget and activities. This would include:

- ensuring Project schedules are implemented in a timely manner, approving and, if necessary, modifying Study Sub-Component activities prior to implementation;
- monitoring the performance of the collaborating institutions involved in the Study Sub-Components, and if found to be unsatisfactory, terminating the relevant agreements and identifying alternative collaborators;
- ensuring that proper procedures are established for reporting to the Project's Steering Committee;
- instigating appropriate accounting procedures;
- relaying policy and other directives to Project staff, and modifying the Project's activities to satisfy them;
- ensuring the production of appropriate outputs for assimilation the proposed awareness programmes;
- identifying, in conjunction with senior project staff, further studies required;
- overseeing and co-ordinating training programmes;

Socio-Economist

Qualifications and Experience Required

58. The applicant should have attained an MSc or equivalent, and have had at least 5 years experience in the socio-economic aspects of agricultural or environmental management or development. Candidates with previous involvement in livestock related projects in general, and range or arid land programmes in particular will be favoured. Computer literacy to a high standard, particularly relating to Windows based software, and proven familiarity with computerised statistical analysis is required.

59. Knowledge of participatory rural appraisal field survey techniques and the design and implementation of questionnaire based surveys, is essential. Experience of establishing rural/pastoral development networks and community based environmental awareness programmes would be an advantage.

Tasks

60. The appointee's primary tasks would be to provide a socio-economic orientation PRIME's database analysis and interpretation, and to help in the preparation of material to contribute to the Unit's planned awareness programmes. This would include: participation in the design and preparation of Workshops, Seminars, Radio and TV Programmes, Newsletters, and Audio-Visual programmes; and recommending to the other PRIME staff, where necessary,

appropriate socio-economic parameters to be included in their analyses. This would entail acquiring a comprehensive knowledge of local farming systems and socio-economic activities in rural Jordan.

61. The successful candidate will also be expected to design, implement and analyse the findings of participatory surveys, the objectives of which would be to: obtain objective assessment of socio-economic circumstances; establish a dialogue with pastoralists and other rural inhabitants, concerning the problems of rangeland rehabilitation; and promotion of sustainable utilisation of rangeland resources. These surveys would also aim to assess pastoralist reaction to proposed interventions or policy changes designed to improve the condition of Jordan's rangelands. This is likely to involve establishing networks in relatively remote areas, arranging village meetings and soliciting stock owners co-operation with PRIME.

62. The appointee would also be responsible for co-ordinating the socio-economic aspects of the Study Sub-Components, to ensure their compatibility with each other, so that a national perspective can be identified. This would include close collaboration with the institute executing the proposed Detailed Herd Monitoring, and with other socio-economic studies being conducted from the Safawi Field Centre.

63. The appointee would also be responsible for making contacts with existing community based networks, informing them of PRIME's activities and objectives, and co-opting their support and collaboration.

Range Management Officer

Qualifications and Experience Required

64. The applicant should have an MSc, or equivalent, and have had at least 5 years experience in rangeland or ecological monitoring with an emphasis on the interactions between livestock and their environment. Candidates with previous involvement in range or arid land programmes, and with some knowledge of the edaphic, hydrological and botanical aspects of range quality will be favoured.

65. Computer literacy to international standards, particularly relating to Windows based software, and proven familiarity with computerised statistical analysis of substantial databases is required. Experience of GIS systems, computer networking, and knowledge of remote sensing techniques and image processing procedures is essential. Experience with UNIX based operating systems would be an advantage.

Tasks

66. The appointee's overall task would be to co-ordinate and supervise the field programmes carried out through the Project's Range and Soils Study Sub-Components. This would include ensuring that their sampling programmes and data collection activities were appropriate to the Project's primary objective of providing a national perspective of range condition and distribution.

67. Regular and frequent trips accompanying the field teams would be required to monitor the quality and type of information being gathered and to ensure the timely execution of the sampling schedules so that reliable seasonal information was acquired where necessary.

68. The Specialist would be responsible for providing the requisite data to PRIME's monitoring and evaluation and data processing staff in a clear and comprehensible manner, and for ensuring that the details and significance of the figures were understood by all concerned.

69. In conjunction with the Socio-Economist and Senior Monitoring and Evaluation Officer, the appointee would devise an appropriate analysis strategy designed to produce information and interpretations suitable for use by both the technical and lay recipients of the Unit's outputs. Active participation in the interpretative process would also be required.

70. The appointee would be expected to maintain a close working relationship with the Socio-economist and the Senior Monitoring and Evaluation Officer. Advice would be available from the Project Manager and a Technical Assistant Environmental Specialist in PRIME. In addition, there would be support in establishing Study Sub-Components from several short term consultants, including Specialists in Range Management and Monitoring, Remote Sensing, Soils Data Base and GIS, Soils and Land Use, Soil and Water Management and Land Use.

Senior Monitoring and Evaluation Officer

Qualifications and Experience Required

71. The applicant should have an MSc, or equivalent, and have had at least 5 years experience in agricultural or environmental monitoring. Candidates with previous involvement in livestock related projects in general, and range or arid land programmes in particular will be favoured. Computer literacy to international standards, particularly relating to Windows based software, and proven familiarity with computerised statistical analysis of substantial databases is required.

72. Experience of GIS systems, computer networking, and knowledge of remote sensing techniques and image processing procedures is essential. Experience with UNIX based operating systems would be favoured, and working experience with ArcInfo or ERDAS would be a great advantage.

Tasks

73. The appointee would be responsible for the more technical aspects of the Project's data collation information gathering activities, would assure both the statistical validity of the field data collection programmes, and ensure the compatibility of the various data types obtained during the course of the Study Sub-Components. An important aspect of the post's responsibilities would the production of the primary results required by each field study, as defined by their stated objectives. This group of activities would necessitate the appointee's participation at every level of the design and execution of the field programmes.

74. A major responsibility of the post would be the integration of the data collected into a single database system, accessible to the statistical, image processing and GIS elements of the Unit's software suites. The Officer would, thus, be responsible for liaison with the collaborating institutions and setting up efficient data transfer schedules and procedures between the various sites involved and PRIME, as well as cataloguing and formatting of the data, and their integration.

75. The Appointee would also be responsible for the analysis and interpretation of the database information, in relation to the directives or requests of Project management, and the specific needs of the various collaborating institutes. Identifying the relevant analyses to provide answers to questions of policy or implementation would be an important part of this task. Similarly, providing appropriate quantitative material for use in the various awareness programmes would be a high priority.

76. The successful candidate would be expected to supervise a team of assistants comprising two BSc Grade Monitoring and Evaluation Officers, and four Diploma level Data Entry Computer Operators, and to maintain a close working relationship with the Socio-economist and Range Management Officer. Advice would be available from the Project Manager and two Technical Assistants, an Environmental Specialist and an Information/ Image Processing Specialist. There would be additional support at the level of the Project Sub-Components from short term consultants in Remote Sensing and Soils Data Base and GIS.

Monitoring and Evaluation Officers

Qualifications and Experience Required

77. The applicants should have a BSc or equivalent, and have had at least 2 years experience in agricultural or environmental monitoring. Candidates with some involvement in livestock related projects in general, and range or arid land programmes in particular will be favoured. Computer literacy to international standards, particularly relating to Windows based software, and familiarity with computerised statistical analysis of substantial databases is required. Some knowledge of the principles of GIS systems, remote sensing techniques and image processing is essential.

Tasks

78. The personnel appointed will be expected to assist the Unit's senior staff in the day to day supervision of data preparation, processing and data entry, as required. Of particular importance will be the cataloguing and organisation of the raw and processed information, to facilitate efficient retrieval and analysis, as well as controlling the quality of the processing and data entry procedures.

79. After an initial period of 'on the job training', the appointees will be expected to carry out routine analyses under the close supervision of the senior staff, and to assist in the extraction and presentation of the Unit's findings. This will involve compiling summaries of the data and producing descriptions of them when required.

80. Some exposure to field work will be mandatory, in order to promote an understanding of the data structure, content and significance. This will help ensure effective data quality control and error trapping. It is also likely that the appointees may be seconded for short periods to collaborating organisations to assist with routine data processing and validation tasks arising during the course of the various Study Sub-Components.

81. External training in more advanced GIS, image processing and analysis techniques will be provided according to aptitudes developed during the normal course of the Unit's activities. It is likely that one Officer would become more involved with the data analysis and

presentation elements of the Project's work, whilst the other would be more often assigned to the field data collection and processing tasks.

Technical Assistance - Environmental Specialist

Qualifications and Experience Required

82. The applicant will require a PhD or equivalent, and at least 10 years experience in an environmental, ecological or agricultural field relating to resource assessment or management. Substantial field experience of arid or dryland environments is essential, and a firm practical grasp of both ground-based and remote sensing techniques of data collection is required. Computer literacy in presentation techniques and statistical analysis to advanced international standards will be needed.

83. Familiarity with livestock in general and small ruminants in particular, and previous experience in the Middle East would be an advantage, as would exposure to rangeland projects. A propensity and enthusiasm for field data collection is essential.

84. The candidate should have had some experience of either training local staff to an advanced level, or have done a substantial amount of post-graduate teaching. Fluent spoken and written English is essential and a passing knowledge of Arabic would be an advantage.

Tasks

85. The appointee's chief duties would be to work closely with the Range Management Officer, providing technical support and advice, if and when required, for the successful execution of the field study programme and its integration with other Project activities. The focus would be on building up the capacity of PRIME and its associated institutions for the sustainable collection and interpretation of meaningful data on rangeland resources.

86. There should be careful supervision of field studies under the Project's Range and Soils Study Sub-Components, particularly in their early stages but also throughout subsequent years of operation. At the outset of any given Study, the Environmental Specialist would work closely with the respective short term consultant, briefing him/ her on the local environmental and administrative situation, overseeing the design of appropriate data collection and analysis methods and ascertaining that the research teams are sufficiently prepared. The Specialist would co-ordinate the design of the different field studies - of rangeland vegetation, soils and livestock - within an overall framework which ensures consistency and compatibility of all the data types.

87. Once studies are established, regular monitoring of the type and quality of data being produced would be required to make sure that reliable information continues to be available as and when needed. Periodic field trips with study teams would be necessary to determine that standards of data collection are maintained and that the Project activities remain on schedule.

88. In collaboration with the Monitoring and Evaluation staff and the Socio-economist, the successful candidate would help to analyse and interpret the accumulating data in accordance with primary Project objectives and in response to the needs of Government planners and of awareness programmes.

89. The Specialist would be expected to participate fully in the Project's formal and informal training programme, providing practical on-the-job experience for senior and junior staff of PRIME and participating in the development and implementation of short term refresher/conversion courses at the University of Jordan and other institutes.

Technical Assistance - Information/Image Processing Specialist

Qualifications and Experience Required

90. The applicant will require a Ph.D. or equivalent, and have had at least 10 years experience in an environmental, ecological or agricultural resource assessment, data management and statistical analysis. At least 5 years experience with remote sensing applications, satellite image processing, and GIS use is also required. The applicant should have expert capabilities in the use of UNIX and IBM compatible PC platforms, and will need to be a competent operator of ArcInfo and a high level image processing software package such as ERDAS Imagine.

91. Previous experience in the Middle East would be an advantage, as would exposure to rangeland projects. The candidate should have had some experience of either training local staff to an advanced level, or have done a substantial amount of post-graduate teaching. Fluent spoken and written English is essential and a passing knowledge of Arabic would be an advantage.

Tasks

92. The position's primary responsibilities would initially be to assist and co-ordinate the establishment of PRIME's GIS and data management capability; to identify and provide training to project staff as required. This is likely to include: defining data format constraints; ensure proper software/data presentation capability; train local staff in Microsoft Office capabilities and LAN networking; investigate possibilities of mobile phone Wide Area Networks; and train staff in basic analytical and mapping techniques

93. The appointee would define and implement the analyses and interpretation of available data concerning pastoral resources in Jordan. This would involve setting up the Unit's primary database, by incorporating available data into GIS format (probably ArcInfo).

94. The appointee would also be responsible for liaison with collaborators to set up data standards, data transfer schedules and protocols, and to ensure that the relevant equipment provided to co-operating bodies was correctly installed and functioning adequately.

95. Together with the Image Processing Specialist, the successful candidate would assist in setting up semi-automated image processing protocols with RJGC, and specify the parameters required for inclusion into PRIME's GIS from NOAA and METEOSAT data.

96. Once the Unit's routine data collection and processing capabilities have been established, the specialist would, in close collaboration with other Unit staff, assist in implementing the analyses necessary to interpret the data acquired from the various Study Sub-Components, and would assist with the presentation of these interpretations to planners and to the staff responsible for the awareness building programmes.

97. The specialist would also participate in the Project's formal and informal training programme, involving both on-the-job experience and short term refresher/conversion courses at the University of Jordan and other institutes.

98. Throughout the term of the post, the specialist would maintain, as a high priority, the transfer of skills and expertise to Unit personnel, to ensure the Unit's long term survival

EQUIPMENT AND FACILITIES

99. In addition to standard office furniture and equipment, the senior specialists staff and their TA counterparts would require sophisticated PC computing facilities, each with networked access to laser printers. As it is not known when the Project would begin and information processing is an extremely fast moving field of technology, it is not possible to specify precisely the standards required at the present time, except in general financial terms (See Annex 5, Table A5.15).

100. Assuming 1995 standards, these PCs should be equipped with 17 inch colour monitors, sufficient Random Access Memory (RAM) to run Windows95 in full 32 bit mode - 20MB - CD-ROMs, fax/modems and Gigabyte hard disks. Software should include Microsoft Office95 with Access, Windows95, Word Perfect, and a statistical package such as SPSS. Basic GIS and image processing packages, e.g. Atlas and Idrisi for Windows, should also be installed. Other staff would require less powerful computing facilities, but would still need Pentium processor based PCs, though with less additional RAM, and smaller monitors.

101. The Unit would require A3 digitising, colour scanning and A3 colour printing capability, for the production of maps and publicity material for use in the awareness campaigns. Adequate tape and optical disk drive data backup and storage would also be required

102. In addition to PC facilities, PRIME would require the substantial processing capability that is currently available only from UNIX workstations. These would be provided for both the Range Management and M&E staff, along with ancillary hard disks, and backup devices.

103. The workstations would be equipped with the high specification GIS and image processing software required for compatibility with RJGC facilities. These include ArcInfo and ERDAS Imagine. Should less expensive options be available at Project start-up, then these should be considered only if they are *fully* compatible with other systems used by the collaborating organisations.

104. PRIME would also be equipped with a limited pool of items, such as Global Positioning Systems (GPS), for loan to collaborating organisations. More significantly, in addition to three saloon vehicles for the PM and Technical Assistance Personnel, there should be a pool of 4x4 station wagons for priority use by the field study teams from collaborating organisations. These should be allocated according to the field study schedules on a renewable monthly basis.

AWARENESS BUILDING AND PASTORAL/PUBLIC PARTICIPATION

105. A primary goal of the PRIME is to create greater public awareness of the status of Jordanian rangeland resources and the prospects for their rehabilitation and sustainable development. This would require the sensitisation of all levels of society, from pastoralist to politician, to the various issues involved and the difficult choices and compromises that would have to be made if the rangelands are to survive intact.

106. A major public awareness campaign is called for, involving both rural and urban populations, governmental and non-governmental organisation, research institutes and centres of learning.

107. The campaign would include the holding of workshops, participatory surveys and seminars, as well as contributions for radio and television, production of a regular newsletter and press releases, and the production audio of visual programmes for screening on National television and for video display.

Workshops (US$ 50,000)

108. In the first instance, a "training of trainers" workshop would be held for Queen Alia Fund regional staff, to familiarise them with the status of Jordanian rangelands and pastoral resources, and examine the options available for rehabilitation and sustainable development. Subsequently, a series of local workshops would be held at community centres across the country to raise the awareness of and obtain feedback from local communities. Other dissemination networks, such as the Noor Al Hussein Foundation, the Royal Society for the Conservation of Nature would also be involved. If possible, representatives of organisations such as the Badia Police, who have close contact with pastoralists in the more remote areas would be included in these exercises.

Participatory Socio-economic Surveys (US$ 75,000)

109. OAF staff are well qualified, knowledgeable and widely experienced. They have taken part in a variety of social and economic studies, including a recent baseline socio-economic and animal production survey of the Jordanian rangelands for IFAD[1].

110. The project would build on this collaborative experience and utilise the Fund's extensive network of grass roots contacts to access pastoral communities and bring them into the debate on the future development of Jordanian rangelands. This debate must involve a mutual exchange of information, reflecting the legitimate feelings and aspirations of pastoral communities, whilst at the same time recognising the intrinsic constraints on arid land livestock production, and considering realistic options for rangeland rehabilitation and development.

111. A series of socio-economic studies and surveys of pastoral communities would be undertaken during the course of the project, to complement the findings of the initial baseline survey. These studies would include the establishment of an appropriate sampling frame for monitoring the household economy of pastoral families and the productivity of their livestock, as well as more general surveys to identify communities willing to participate in co-operative rangeland management, and locate areas of rangeland traditionally associated with particular communities.

Seminars (US$ 60,000)

112. During the course of the project a variety of Seminars would be held to discuss the findings of various studies commissioned by the project and sensitise invited participants to the various issues raised. For maximum impact, these Seminars would be targeted at community leaders, influential members of society, academics and professionals in the pastoral resource arena, senior administrators and policy makers.

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[1] *National Programme for Range Rehabilitation and Development: Baseline of Socio-economic and Animal Production Data.* Roger Blench, International Fund for Agricultural Development, North East and North Africa Division, Project Management Department, May 1995.

Radio and TV Programmes (US$ 50,000)

113. In collaboration with Jordanian Television and Radio, independent producers and script writers would assist in preparation of a series topical discussion programmes about pastoral resources, livestock production and rangeland development issues. These discussion programmes should go beyond the conveyance of extension messages, involve the general public and examine issues of competitive land use, land tenure and co-operative community initiative in land use planning.

Network Newsletter/Press Releases (US$ 25,000)

114. A network of organisations and individuals interested in Jordanian rangelands and pastoral resources would be identified and a quarterly Newsletter would be produced by PRIME highlighting current issues in rangeland and pastoral resource development. These would be illustrated by the suitably tailored output from PRIME's analysis and interpretation activities. Press releases would also be issued via the Ministry of Agriculture and PRIME's collaborating institutions

Audio-Visual Programmes (US$ 150,000)

115. Three 30-45 minute documentary audio-visual programmes on Jordanian Rangeland would be professionally produced as training and awareness videos and for screening on National Television. Topics likely to be covered would include: Review of Current Status, Historical Background and Significance of Range Resources; Contrasting Views of the Pastoralist and Urban Dweller; Land Tenure; Land Use Planning; and Sustainable Development: Prospects for the Future.

TRAINING

116. An important element of PRIME's Terms of Reference would be to ensure its long term viability. It is envisaged that sufficient skill be transferred to PRIME's local staff, through both 'on the job' training during the initial baseline assessment, and via specific externally recruited technical supervision in the following years. As the local capabilities were built up, so the input of external technical assistance would be progressively reduced to minimal levels by the end of the Project's expected life.

117. Training would be required in: data management, integration, analysis, and interpretation; mapping and presentation; GIS procedures (particularly for ArcInfo) and file transfer; as well as remote sensing and image processing. It is envisaged that the personnel recruited for these tasks would also serve as trouble-shooters to solve the potential problems of equipment and software installation and compatibility. Given the technical sophistication of most of these topics, the relevant personnel would almost certainly have to be recruited externally.

118. In order to ensure a smooth and progressive strengthening of local expertise, training input would have to be maintained on a regular basis throughout the proposed Project's life. This would have the added advantage that PRIME staff could be kept abreast of software developments, which will undoubtedly continue to be as rapidly evolving as they have been during the past five years.

BACKGROUND ON PROPOSED PROJECT COLLABORATORS

119. This Section is intended to provide relevant information on the institutions which would be PRIME's main collaborators. A number of these are mentioned only briefly below, as their technical expertise and capabilities are considered in some detail in the context of Studies proposed in the other Annexes. These include:

- The Epidemiology and Production Monitoring Division of the Veterinary Department, Ministry of Agriculture (Annex 4)
- The Department of Statistics, Ministry of Planning (Annex 4)
- The Meteorological Department, Ministry of Transport (Annex 3)
- Department of Forestry and Range, MoA (Annex 2)

120. Other organisations are condisered in more detail, though the more technical aspects of their functions are considered in Annex 3. Thes include the Soils and Land Use Division and the Royal Jordanian Geographical Centre.

MINISTRY OF AGRICULTURE

121. The Ministry of Agriculture and the National Centre for Agricultural Research and Technology Transfer (NCARTT) would be important partners in implementation of the Project, and the Ministry will be a major end user of the outputs. The Ministry's institutional context is discussed above.

122. The Ministry, and especially NCARTT, may assist project implementation through the provision of staff, vehicles, facilities and services. For example, sites on Ministry controlled land would be provided to the project when they are needed for trials and demonstrations, and the project would have access to relevant information held by the Ministry, in particular that held at the Department of Forest and Range by the former National Soil Map and Land Use Project.

Soils and Land Use Division

123. The Department of Forestry and Range has a Soils and Land Use Division (SLUD) that is of special importance to PRIME because staff have expertise in the soils and land cover mapping and data base management, including GIS. The Division has recently completed the EU funded National Soil Map and Land Use Project.

124. SLUD has a staff of three senior pedologists, nine pedologists, three data base/GIS specialists and four field technicians. The senior pedologists have specialist skills in soil genesis and classification, and soils data base management.

125. SLUD has two major functions within the Ministry (1) To maintain, update and expand information on soils and land use in Jordan (2) To develop detailed information and specialised knowledge about soils in ways that will help farmers and others improve productivity and maintain sustainability. SLUD is now participating in the University of Jordan EU funded project "Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of Jordan"

126. SLUD could contribute to pastoral resources assessment and monitoring activities of PRIME in several ways:

- Accessing, maintaining, updating and expanding the soils and land use data base.
- In rangeland monitoring activities SLUD would work with RJGC providing field staff for ground truthing satellite imagery and identification of soils influencing NDVI differently (details are provided in Annex 3 of this report).
- Soil survey and land suitability mapping
- Monitoring soil water balance and soil erosion.
- Monitoring influence of cultivation on rangelands

127. SLUD could also provide a link to the EU funded project "Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of Jordan" This would involve the analysis of information about soil distribution in the Steppe zone in relation to possibilities for increasing crop production and improving the rangeland production through erosion control and water harvesting.

128. The following technical and administrative difficulties were evident:

- During the National Map Project there was little time for pedologists to use the DBMS or the SPANS GIS and inadequate time for the GIS/DBMS technicians to be trained fully in specific software products. The computer systems are as a result not used to their full potential.
- The SPANS GIS is capable of rapid spatial analysis of information from large databases. The system has developed using several different computers, some of which are not able to run the latest version of SPANS. Severe difficulties have been experienced in file transfer to other systems used in Jordan .
- The Division does not have facilities for chemical or physical analysis, and lacks equipment for field measurement of soil physical properties.
- It is understood that SLUD has insufficient funds for operation expenses. An annual budget of JD 70,000 is estimated as a reasonable requirement for maintaining facilities at the present level. Project vehicles are essential for field survey work and some of these are due for replacement.
- Work within the private sector increases operational expenses and means for retaining revenue to meet these costs are not yet formalised.

129. Information from the soil data base is useful to many organisations and maximum use of information is encouraged by the Division. Some organisations require help in the analysis and interpretation of the basic data but some organisations require basic data. Safeguards have not been put in place to ensure that ownership of information provided to outside organisations remains with the Ministry of Agriculture.

DEPARTMENT OF THE ENVIRONMENT

130. The Department of the Environment is currently part of the Ministry of Municipalities and Rural Affairs and the Environment. A major function of this Department is to prepare a draft of an Environment Act, for presentation to Parliament. This process has been in train for some years, and it is understood that the first draft required radical re-writing. Details of the current Draft Act were not available, though the Mission was informed that the latest version

had been substantially watered down, and many of the more contentious issues have been removed, in order to facilitate its passage through the political system within the reasonably near future.

131. Part of the Act, presently being considered by Parliament, stipulates a restructuring of the Department, so that it is able to implement the Act's requirements. This restructuring is being actively discussed, though no firm decision has yet been made. The main alternatives appear to be:

- the formation of an efficient Environment Corporation, with powers to commission studies and delegate activities to both the public and private sector, according to demonstrated institutional or professional capabilities;
- the establishment of a new fully-manned Ministry of the Environment responsible for implementation of the Act, largely through existing govermment resources.

132. During the Mission's visit, the balance between seemed to be moving in favour of the second of these possibilities. However, nothing can be implemented until the Environment Act is actually ratified.

DEPARTMENT OF LANDS AND SURVEYS

133. The Department of Lands and Surveys is the body legally responsible for assigning and surveying the land and property prior to the assignation of legal title. The Department is unable to release details of its land registry to either public or private bodies, though it may provide summaries of the area of land registered in each Governorate.

134. Given its legal brief, the Department would be closely involved in any land tenure issues arising from apportioning government land to pastoralists. However, these issues are more likely to be addressed by the NPRRD than the proposed PRIME Unit, and so have not been considered here.

THE QUEEN ALIA FUND

135. The Queen Alia Fund for Social Development (QAF) was founded in 1977. It is a non-profit, non-governmental, social development organisation, governed by a board of trustees and headed by HRH Princess Basma Bint Talal, the only Sister of His Majesty King Hussein.

136. QAF was the first Jordanian organisation to be established with the specific objective of achieving development through support for and direct participation of the underprivileged in self-help initiatives to become economically independent and productive members of society. It the largest organisation of its kind and scope in Jordan, with a network of fifty social community development centres throughout the country.

137. The Fund's work covers a wide range of activities from the training of trainers in areas as diverse as pre-school education and agricultural development, to vocational training and income generating activities for women. The overall goal being to promote sustainable development by helping people to help themselves, rather than to rely on charity.

138. Projects focus on education, awareness building, training and leadership development at grass roots level, giving people the means, skills and knowledge to use locally available materials and natural products for food, building and income generation. It is QAF's policy to

involve as many people as possible in development and share benefits as equitable as possible across all sectors of society.

139. Particular attention has been given to promoting the role of women in the development process, and encouraging their active participation in community life. In addition, QAF seeks to strengthen local community based non-governmental organisations, by offering them technical and financial support and training.

140. The organisation has an excellent track record and reputation for getting things moving. Sponsors include: many of the United Nations agencies; the Arab Fund for Social and Economic Development; the European Union; Japan International Co-operation Agency; USAID; the Governments of Australia, Britain, Canada, China, Germany, Italy and Spain; and international NGOs.

JORDAN CO-OPERATIVE ORGANISATION

141. The Jordan Co-operative Organisation (JCO) has a long and well established history, with a wide variety of specialised groups involved in different productive capacities, including livestock producer and grazing reserve co-operatives (See Annex 2), which rely on close co-operation with the stock owners involved. The resulting networks thus provide a potential mechanism of awareness building and communication with pastoralists.

142. In the agricultural sector, farmer support services provided by JCO include: the sale of inputs, feeds and provision veterinary services; advice on animal health and husbandry techniques; management of grazing reserves and production of forage; supply of improved genetic stock; and marketing and management support. Co-operative groups for women, education and health are also promoted. JCO is also collaborating with BRDP in small scale animal health studies in the Badia (See Annex 4).

143. Following recent changes in financial circumstances, however, a World Bank Mission, planned for early 1996, will review, and possibly reformulate, its long term objectives and structure. JCOs future role and functions remain, therefore, for the time being at least, somewhat uncertain. Nevertheless, it seems likely that many of the organisation's input supply activities will be privatised, although technical advisory services will be continued.

ROYAL JORDANIAN GEOGRAPHIC CENTRE

144. The Royal Jordanian Geographic Centre (RJGC) was established in 1975, as the national focal point for land and aerial survey, and the production of maps. A collaborative development agreement was signed with the French Institut Geographique National (IGN) for the secondment and training of RJGC staff, and the establishment of a specialised training unit to strengthen national capacity in surveying and mapping.

145. The Centre's responsibilities include:

- Establishment, maintenance and updating the national geodetic network and triangulation points covering the entire country;
- Provision of necessary data to the Lands and Survey Department for cadastral mapping;
- Production of base maps and thematic maps for specialised use of Ministries, government bureaux and other institutions;

- Aerial photography and advise on photo-grammetry, photo-interpretation, surveying and map production.
- Training sufficient numbers of specialised technicians to meet the country's needs; and
- Ensuring that existing staff are keep up to speed with rapidly advancing techniques, including image processing, digital mapping; and Geographical Information Systems.

146. A remote sensing section was established in 1985, by order of the Council of Ministers, to promoting the use of new remote sensing techniques in Jordan. A range of SPOT and LANDSAT satellite imagery has been acquired, providing coverage of the entire country at various dates and resolutions for applications in topographic mapping, natural resource assessment, agriculture, hydrology, geology, urban and regional planning.

147. In conjunction with the Higher Council for Science and Technology's National Information Centre, the RJGC is participating in the establishment of a National System for Geographical Information and the creation of an electronic network of information exchange.

148. The RJGC is fully equipped for all stages of map production, from the acquisition of conventional aerial photography and photo-grammetry, to printing and publication. The specialised training unit has been upgraded to become a College of Survey Sciences catering for training needs of Jordan and the wider region, with courses in modern methods of Topographic Survey; Cartography and Photo-grammetry; and Survey Sciences. The College runs a range of training courses on resources assessment and survey techniques and the Centre has hosted a variety of international seminars and symposia on remote sensing and GIS applications.

HIGHER COUNCIL'S FOR SCIENCE AND TECHNOLOGY

Jordan Badia Research and Development Programme

149. A memorandum of understanding between the Jordanian Higher Council for Science and Technology (HCST) and the British Royal Geographical Society (RGS) was signed in 1992 to embark upon a joint research and development programme for the north-eastern Badia, with the technical support of Durham University's Centre for Overseas Research and Development (CORD).

150. The overall objective of the programme is the "sustainable development of the desertified Badia environment and the improvement of the standards of living of the inhabitants." This is to be achieved through: conserving natural resources and the adoption of appropriate management systems that will provide sustainable levels of production in the long term; optimising returns from investments already made in the region by the identification and alleviation of development constraints; enhancing the returns on future investments by optimal allocation of resources; application of appropriate forms of technology; training and community participation.

151. The region of study occupies an area of some 11,210 square kilometres of the North-eastern Badia within the boundaries of Al-Mafraq and Zarqa Governorates, and includes 35 villages with a total population of 15,318. Field activities are based at a well equipped research station at Safawi and focus on the following areas of interest:

- **Human Sciences:** Demography, anthropology, sociology, archaeology, economic development, public administration, education and health;
- **Agriculture and Biological Sciences:** Livestock production, plant production, biodiversity and wildlife ecology;
- **Environmental Sciences:** Geology; hydrology, soil science, minerals and energy, remote sensing, Geographical Information Systems.

National Information Centre

152. The collection and dissemination of information in Jordan is subject to a number of legal conditions. For example, all official agricultural data is currently the responsibility of the Department of Statistics, whilst all geographic information is controlled by the Royal Jordanian Geographic Centre. In theory, any institution intending to assemble or collect data pertaining to these topics should obtain the permission of the designated authority.

153. There is however some flexibility in the system. For example, the Ministry of Agriculture has an agreement with the Department of Statistics allowing it to collect and process agricultural data for its own purposes, and to disseminate them where appropriate.

154. There is an on-going GTZ funded project that is setting up a National Information System (NIS), co-ordinated by the National Information Centre (NIC) within the Higher Council for Science and Technology (HCST). The Centre's responsibilities set out in its Bye Laws include:

- The Establishment of a National Information System: *An integrated national information system will be established and managed by NIC. Various information centres in the private and public sectors will be linked together to provide users with up-to-date information in different subjects.*
- Organisation and Co-ordination. *To facilitate retrieval of information and provide easy access to information, NIC will organise and co-ordinate relations between sources of information, eliminate unnecessry repetition/contradiction and standardise procedures.*
- Standardize Procedures. *Through its technical committees and expertise, NIC will set up standards and procedures to organise and co-ordinate information input and output at the national level*
- Create Awareness. *To raise the level of awareness, promote understanding and enhance co-operation among institutions for better understanding and implementation of information standards and procedures, NIC will create awareness by organising seminars and workshops.*
- Software Development. *To develop software according to its set standards*
- Training. *To organise training courses in an effort to increase the efficiency of data inputting and retrieval*
- Establishing Databases. *To assist in establishing databases, information gathering centres and referral sources of information.*
- Consultancy Service. *To provide consultancy services to both private and pubic sectors in developing information sources.*
- Surveys and Studies. *To conduct surveys and studies necessary for the progress of the information system and upgrading of services to suit user needs.*

- Information Services. *Being at the centre of the national information system, NIC will be able to provide users with all kinds of information services including search services from the local and international databases.*
- Publications. *NIC will issue various reports and publications about the activities of the Centre and other information centres in the network. Booklets, manuals, guides and directories will be published to help users in their search for information.*

155. Of the 17 Information Sectors Co-ordinating Committees set up, four are concerned with topics relevant to PRIME's proposed activities. These are: Agricultural; Environment; Natural Resources and Water; and Geography

156. NIC is currently preparing a data register, which will be accessible by modem, and will specify the type and location of data available in a series of nodes connected by a Wide Area Network, each covering specific fields. The system is planned to be functional by the end of 1995, and will allow any institution connected to the Network to download summary data from any node. If more detailed information is required, users will be informed of the relevant locations, and may, in certain cases, be able to access the sources via the node system.

157. If this system is implemented in its entirety, NIC will have to be informed of any major data gathering exercise, and may require the data to be provided in compatible format to the relevant node. There may also be a requirement for prior discussion with the relevant authority to identify particular information categories that should be made available.

ROYAL SOCIETY FOR THE CONSERVATION OF NATURE

158. The RSCN is an independent, voluntary organisation devoted to the conservation of Jordan's natural resources. It was created under the patronage of His Majesty King Hussein and it has been given responsibility by Government for protecting the county's wildlife and wild places. This being accomplished through a variety of inter-related activities, including

- setting up nature reserves and national parks to protect the best wildlife areas;
- breeding endangered species to save them from extinction;
- enforcing Government laws for the protection of wildlife;
- controlling illegal hunting;
- raising awareness of environmental issues through education programmes
- promoting the sustainable use of natural resources; and
- helping to fight pollution.

159. The Society is one of the few voluntary organisations in the Middle East to have been given such a public service mandate, and as a result of its pioneering conservation work the organisation has received international recognition and acclaim. Major achievements include:

160. Establishment of six nature reserves covering over 1,000 square kilometres. These protect not only wild plants and animals but other natural resources such as water supplies. They are also some of the finest natural landscapes in the country. A further six reserves are planned.

161. The successful captive breeding of the endangered Arabian Oryx, gazelle and Ibex, and their re-introduction to the wild.

162. The setting up of over 400 hundred Nature Conservation Clubs in schools which help children to understand environmental issues and become involved in practical conservation projects. The Society's conservation and environmentally oriented magazine, El-Reem, was the first of its kind to be published in the Arab world and is distributed widely.

163. The control of illegal hunting throughout the Kingdom has been delegated to the Society from the Ministry of Agriculture. RSCN has responsibility for issuing hunting licences and maintains a well equipped law enforcement team.

164. The monitoring and control of pollution in the Gulf of Aqaba. The society has a patrol launch for monitoring marine pollution and coral reef protection.

165. The promotion of large-scale conservation programmes designed to integrate environmental protection with the socio-economic aspirations of local people, including the mounting of environmental awareness campaigns and encouraging the participation of local communities in the development of the Dana Reserve.

166. The policies and general activities of the Society are shaped and governed by an elected Board of Directors, supported by a number of specialised sub-committees. Responsibility for day to day work is delegated to a team of over 50 staff, headed by the Director General. This work is organised into four main functional divisions: conservation, public awareness, fund raising and administration. Apart from committee members and staff, the Society also has over 600 members, representing interested and committed people from all walks of life.

167. Like many voluntary societies, RSCN raise its own income from many sources, including membership fees, donations and sponsorship. It also receives an annual allowance from Government in recognition of its role in enforcing wildlife protection laws and in catering for protected areas.

UNIVERSITY OF JORDAN'S PROJECT FOR THE IMPROVEMENT OF AGRICULTURAL PRODUCTIVITY IN ARID AND SEMI-ARID ZONES OF JORDAN

168. The project was launched in December 1994 and is due to run for a period of four years. It is a co-operative venture of the Faculty of Agriculture and the Ministry of Agriculture, co-financed by the European Union and the University of Jordan, with technical assistance from Silsoe College, Cranfield University, UK, supported by Hunting Technical Services Limited, UK, and the International Centre for Agricultural Research in Dry Areas (ICARDA). The overall cost of the project is 2.6 million ECU, of which the European Union will provide 2 million ECU as a grant with the remainder being provided by the Government of Jordan .

169. The overall objective of the project is to contribute to the sustainable development of the Badia lands of Jordan by providing a basis for the optimal use of the region's land and water resources. Its principal contributions will be: to build on the achievements of earlier work at the University's 200 hectare Field Research Station at Muwaqar, 40 kilometres south-east of Amman; to develop and promote improved techniques for producing crops and livestock; to formulate comprehensive land use recommendations aimed at optimising the region's scarce rainfall; and to start the process of technology transfer.

170. The project is divided into four broad thematic areas of study: Land Use Planning; Water Utilisation Techniques; Farming Systems Improvements; and Technology Transfer; each of which is sub-divided into a series of researchable topics summarised below:

- *I Land Use Planning*
  Development of a data management system and geographical information system for the land and water resources of the project area;
  Evaluation of the components of the water balance of catchments in the project area and the potential for modifying them;
  Assessment of the environmental impact of proposed technical packages and establishment of a long term environment monitoring scheme;
  Development of recommendations for the optimal use of land and water within catchments.
- II *Water Utilisation Techniques*
  Design and testing of appropriate water spreading and water harvesting techniques;
  Design and testing of appropriate supplementary irrigation methods using run-off stored in small dams;
- III *Farming Systems Improvement*
  Development and testing of techniques for managing the physical condition of the soil and increasing the availability of soil water and nutrients;
  Development of techniques for increasing rangeland productivity;
  Development of crop and forage production enterprises for integration with sustainable livestock production systems;
  Development of improved livestock production systems based on increased production from rangeland and crops;
- IV *Technology Transfer*
  Collection of socio-economic data and assessing the social and economic acceptability of proposed technical packages;
  Extension of promising and environmentally sound technical packages within the project area.

OTHERS

171. The project acknowledges that low rainfall areas of Jordan have attracted a variety of other project initiatives in recent years, and it is therefore proposed that informal links should be established with these organisations to gain from their experience, and avoid duplication of effort. Where appropriate, more formal collaboration will be considered, whether in connection with development and testing of techniques, formulation of land use recommendations, or technology transfer. Such organisations would probably include the Development Agencies, such as GTZ, various UN Agencies, and research organisations such as ICARDA.

POTENTIAL SOURCES OF FUNDS

DESERTIFICATION CONFERENCE

172. See Main Report, Appendix 1.

GEF

173. The Global Environment Facility (GEF) is a financial mechanism that provides grant and concessional funds to developing countries for projects and activities that aim to protect the global environment; in particular those that address the following concerns: a) climatic change; b) loss of biological diversity; c) pollution of international waters; and b) depletion of the ozone layer.

174. Jordan currently receives GEF support for two projects: one of which aims a building capacity to respond to the challenges and opportunities created by national response to the Framework Convention on Climate Change (US$242,000); and the other, which provides support for biodiversity conservation and environmental management of the Dana and Azraq protected areas (US$6.3 million). The latter project is linked to the Royal Society for the Conservation of Nature and includes a public awareness programme for the conservation of nature and protection of the environment, targeted at some 400 nature conservation clubs at schools across the country.

175. Whilst the National Programme for Range Rehabilitation and Development would, if successfully implemented, eventually contribute to the conservation of biodiversity in Jordan, this remains a somewhat distant and uncertain prospect. However, GEF might be interested in supporting the initial Pastoral Resource Assessment and Monitoring Component of the programme, although in the view of the consultants this is an unlikely prospect, because of GEF's current support for biodiversity conservation in Jordan RSCN.

METAP

176. The Mediterranean Environmental Technical Assistance Program (METAP) involves a consortium of donor agencies, including The World Bank, the United Nations, European Union and the European Investment Bank. Target countries initially included those bordering the Mediterranean, through Jordan was invited to join during 1995. There are four major program areas: **capacity building and participation**; arresting pollution at "hot-spots"; integrated water management; and **natural resources management and conservation.**

177. The Capacity Building and Participation Program includes the following modules:

- Finalising, updating or implementing national environmental plans;
- Establishing an appropriate legal and institutional setting;
- Decentralisation of operational functions of environmental management;
- Strengthening the capacity of staff in environmental and sectoral ministries and public agencies;
- Developing and implementing plans of action for monitoring pollution problems and enforcing environmental objectives and standards;
- Strengthening existing and developing new information centres and regional networks;
- Supporting participation of affected parties, the public, the private sector, local NGOs and the media in decision taking.

178. The Natural Resources Management and Conservation Programme includes the following modules:

- Supporting the introduction of broad community participation in planning and implementation of sustainable land use practices;
- Facilitating the implementation of pilot projects to demonstrate and test community based initiatives to introduce sustainable land use practices;
- Supporting preparation and implementation of river basin plans and strategies for integrated soil and water management;

- Supporting the organisation and operation of agro-ecological zone districts to create a forum and mechanism to bring together all stake holders (both public and private) to participate in the preparation of integrated management plans;
- Strengthening preservation and management of cultural heritage sites.

EU

179. The European Union previously funded the Soils and Land Use Mapping Project, and is currently supporting the project for the Improvement of Agricultural Productivity in Arid and Semi-Arid Zones with University of Jordan. Under current protocol, expiring during 1996, funds are fully committed, but there are likely to be contingencies which may not be fully used.

180. The next phase of funding will be organised in a new way, and will involve a ECU4.6 billion regional Mediterranean fund, which will not be country specific. Jordan is entitled to request access to regional funds, and in the past has been more successful than most.

181. Following the percieved success of the Soils and Land Use Project, the Department of Forestry and Range has been approached in the fairly recent past for proposals, but no response have been, as yet, forthcoming. Despite this, it is possible that EU would view requests for funding projects based at the Department sympathetically.

GTZ

182. GTZ is already committed to supporting agricultural sector reform and the overhaul of extension services. Current thinking is, however, that too much emphasis had been given to agriculture in the past, and that this would change in the future. It seems unlikely, therefore, that GTZ would be willing to provide funds to PRAMCP.

OTHERS

183. Meetings were held with both the ODA of the United Kingdom and USAID, at which the aims of the proposed Project were discussed. Though they asked to be kept informed of progress, neither body expressed more than polite interest.

The Hashemite Kingdom Of Jordan

National Programme for Range Rehabilitation and Development

Pastoral Resources Assessment, Monitoring and Co-ordinating Project

ANNEX 2: RANGELAND

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

1. Following the preparation of the formulation report (IFAD, 1993) of the proposed National Range Rehabilitation and Development Programme, a Mission visited Jordan to prepare a Pastoral Resources Assessment and Monitoring Component. The Mission objectives were:

- to identify and evaluate information concerning pastoral rangeland and livestock related resources in Jordan and to assess specific areas where relevant data are inadequate or unreliable; and
- to evaluate resource assessment and monitoring requirements and identify priorities for institutional strengthening.

2. The main report of this Mission identifies a technical assistance Project which would be implemented by a Pastoral Resources Information and Monitoring and Evaluation Unit (PRIME).

3. This annex was prepared by the Range Assessment and Monitoring Specialist, who was required to:

- identify and evaluate programmes and studies currently assessing and monitoring rangeland forage resources;
- identify the areas requiring enhancement, including the degree of locally available expertise in relevant skills, and recommending levels of training required to bring local capacity to the requisite standard;
- in collaboration with other Mission members, assess the appropriateness of different ground, aerial and satellite based monitoring techniques for acquiring and interpreting data on rangeland quality, degradation and recovery;
- in collaboration with other Mission members, particularly the Soils and Land Use Specialist, specify the requirements for, and designing if appropriate, a protocol for land capability mapping; and
- design field and remote sensing studies and programmes, in close collaboration with relevant Jordanian institutions, to assess and monitor the condition of rangelands in relation to climatic variation and to changes resulting from interventions through the Programme for Rangeland Rehabilitation and Development.

4. The Appendix was prepared by the GIS and remote sensing specialist.

5. The available information and facilities relating to range assessment and monitoring are reviewed, and found lacking in several important respects. While there exists a measure of personal experience and a great deal of semi-quantitative estimation of forage productivity, firm data on rangeland plant biomass and growth relationships are scarce. There is a very limited geographical scope to the existing information, together with a lack of temporal perspective in which to view the current and developing situation. In addition, there is limited understanding of the limits of variation in plant cover and composition which can result from the interaction of a variable climate with diverse soils and hydrology, quite apart from the additional impact of domestic herbivores.

6. The rationale for the collection of good quality and timely information on pastoral resources is to allow decision-makers to plan and implement appropriate interventions for improving the livelihood of pastoralist resource users. Interventions aimed at the alleviation of poverty through improved management of widespread native rangelands should be designed for maximum effectiveness with a clear understanding of the determinants of rangeland forage productivity.

7. Without such knowledge of likely vegetation response to management actions, development activities could have ineffective or even negative consequences. A system providing accurate, up-to-date information on the pattern and trends of forage production, available on a continuous basis on a nation wide scale, would allow the tracking of rangeland vegetative cover in response to rainfall and livestock distribution and possibly "early warning" anticipation of crop or forage production failure.

8. The concept of "degradation" in arid rangelands and the utility of attempting to define a simplistic "carrying capacity" for livestock in such regions have been an increasing focus of debate in recent years (e.g. Behnke *et al.*, 1993: Dahlberg, 1994). Because productivity is determined to a large extent by rainfall, and because rainfall is low and generally highly variable in dry lands, it is increasingly recognised that the dynamics of forage production and rangeland condition may be driven at least as much by climate as by grazing impact. An aspect of degradation can therefore now be defined in terms of the ability of land to yield livestock products of benefit to people, as affected by both abiotic factors and use intensity.

9. Concentrated and continued grazing can have the effect of reducing the resilience of the pasture to respond to periodic shortages or abundance of rainfall. Since it may be impossible to define a single figure for "carrying capacity", a more flexible approach to rangeland management is advocated, in which forage abundance is examined in relation to the spatial distribution of rainfall, soil characteristics and livestock density. Interventions to improve productivity should be planned so as to take advantage of favourable environmental conditions.

10. Information from an improved system for describing and monitoring rangeland forage productivity could be used by decision makers in the Jordanian government, the private sector and other countries in the region, both by example and through internationally co-ordinated efforts at improved management of communally used rangelands.

AVAILABLE INFORMATION AND EXPERTISE

11. Information relating to rangeland vegetation cover and management was examined to identify strengths and gaps in the information relating to Jordan's rangelands. Discussions were held with staff of the following institutions:

- Range Division, Department of Forestry and Range, Ministry of Agriculture;
- Soil and Land Use Division (SLUD), Department of Forestry and Range;
- National Forecast Centre (NFC), Meteorological Department, Ministry of Transport;
- Royal Jordanian Geographic Centre (RJGC);
- Badia Research and Development Project (BRDP), Higher Council for Science and Technology (HCST);
- Departments of Agriculture and Soil Science, University of Jordan;

- National Centre for Agricultural Research and Technology Transfer (NCARTT);
- Royal Society for the Conservation of Nature (RSCN);
- Jordan Co-Operative Organisation (JCO).

12. A field visit was also made to the BRDP Field Centre which is supported by technical assistance from the Centre for Overseas Research and Development (CORD), University of Durham, and from the Overseas Development Administration (ODA), UK.

13. The helpful co-operation given by the staff of all these institutions is gratefully acknowledged.

14. The most important sources of published data are listed in Table A2.1.

Table A2.1: Published Rangeland Resources Information

Title	Date	Author	Institution
Current situation and future potential of dry rangelands in Jordan	1992	K. Tadros	ICARDA
Sheep and Goat Management Systems in Jordan, Traditional and Feedlot. A Case Study	1992	Nabulsi et al	ICARDA
Co-operative role in rangeland development	1993	J.A. Nahleh	JCO
Rangeland resource management at Lajjoun area	1993	Tadros & Salem	ICARDA
JOCSIS - Jordan Soil and Climatic Information System	1993	Anon	SLUD, MoA
Formulation Report. National Programme for Range Rehabilitation and Development	1993	Anon	IFAD
Jordan Agricultural Sector Review: Low Rainfall Zone	1993	Juneidi & Abu-Zanat	USAID
Holistic Range Resources Management in Jordan	1994	M. Shahwan	MoA

RANGELAND VEGETATION MAPPING

15. On the basis of isohyets of average annual rainfall (see Figure A3.5), the rangelands of Jordan have been categorised in agro-climatic zones as: Highlands, Steppe and Badia, in order of decreasing rainfall (Table A2.2, Figure A2.2). It is noted by IFAD (1993) that statistics on land use in Jordan are incomplete and often contradictory, but that it is generally accepted that some 8,340,000ha, or 95% of the total land area, is of potential use as rangeland.

16. Since 1956, a number of maps of rangeland vegetation have been developed or compiled. These are of varying precision and type, including a "rangeland classification" (HTS, 1956; HTS & SSLRC, 1991) which is essentially a landscape classification, bioclimatic maps taking into consideration rainfall and vegetation associations (Long, 1957; Tuttle, 1971; Al-Eisawi, 1985) and floristic vegetation maps (Kasapligil, 1956; FAO, 1991).

Table A2.2: Agro-Climatic Zones of Jordan

Zone	Rainfall (mm)	Area (ha)	% of Total Land Area
Highland	200-600	~200,000	2.5
Steppe	100-200	~1,000,000	11.5
Badia	<100	~7,100,000	82.0

Source: IFAD (1993)

17. Most of the mapping units in these studies were fairly coarse grained, since the field-based ground truthing work was limited, and the purpose of the exercise was to produce maps at the national level. The overlays produced at 1:25,000 scale by Hunting Technical Services (HTS, 1956) are stored in the Soil and Land Use Division, Department of Forestry and Range, and the original photomosaics are stored at the Royal Jordanian Geographic Centre.

18. The National Soil Map and Land Use Project, established in 1990 with the assistance of Hunting Technical Services and the Soil Survey and Land Research Centre (Cranfield University), developed a comprehensive database of digitised maps from the early work of HTS (1956), revised in HTS & SSLRC (1991) and of FAO (1991). Examples of these maps, which are compiled in the JOSCIS database (Bechtold, 1993a & b) are given in Figures A2.3 and A2.4 respectively. Note that the FAO floristic association map, which was produced at 1:250,000 scale for the whole country, contains more detail on vegetation communities within the broader rangeland types defined by HTS (1956), HTS & SSLRC (1991) and by Long (1957). The Figure is intended to demonstrate this complexity, rather than show any meaningful floristic detail.

19. The Soil and Land Use Project described and mapped soils and land use categories in Jordan based on reconnaissance level (Level 1), semi-detailed (Level 2) and detailed (Level 3) survey work. During the Level 1 studies, the country was divided into 18 physiographic land regions, which were used to guide subsequent sampling at the more detailed Levels. In the course of these surveys and those at the other Levels, observations of simple floristic vegetation associations were made and a map of vegetation types, based on the HTS & SSLRC (1991) Rangeland Classification mapping units and four "agroecological" zones, based on climate, topography and soils, was produced (Figure A2.2). A more complete description of these mapping activities, as well as the personnel, activities and output of the National Soil Map and Land Use Project is contained in Annex 3 of this report. The Soil and Land Use Project is now a separate Division within the Department of Forestry and Range.

20. Depending on the mapping system chosen, the vegetation of Jordan can be cast into a variety of different vegetation zones. According to the work of Tuttle (1971), which has been taken up by Juneidi & Abu-Zanat (1993) and IFAD (1993), there are six basic rangeland zones. The classification of HTS (1956) and HTS & SSLRC, (1991) provides twelve vegetation types (see Figure A2.3), and the vegetation map developed by FAO (1991) describes some 120 vegetation associations (Figure A2.4).

21. None of these maps have been extensively checked or validated by systematic vegetation surveys and there is a clear need to do so.

22. The Jordan Badia Research and Development Programme has access to a variety of remote sensing imagery, and plans to produce detailed maps of the vegetation in their study area in the north-eastern Badia (BRDP, 1994).

RANGELAND VEGETATION COMPOSITION AND PRODUCTIVITY

23. The available information on rangeland composition and productivity in Jordan is extensive but sketchy. Detailed information is limited to 32 grazing reserves (Range Reserves established by the Ministry of Agriculture and the Jordan Co-operative Organisation) and nature conservation protected areas (Wildlife Reserves established by the Royal Society for the Conservation of Nature). Little work has been done in the broader rangeland areas of most of the country, apart from anecdotal reports and some semi-quantitative estimation undertaken by the IFAD (1993) Mission.

Table A2.3: Range Reserves Managed by the Range Division, (MoA), and the JCO.

Reserve Name	District	Manager	Year Established	Area (ha)	
				Total	Planted
Khanasri	Mafraq	MoA	1946	455	300
Surra	Mafraq	MoA	1946	396	300
Sabha	Mafraq	MoA	1947	1,054	900
Dab'ah	Amman	MoA	1979	300	50
Adasia	Amman	MoA	1980	2,000	1,200
Wadi Butum	Zarqa	MoA	1986	1,500	100
Azraq Desert	Zarqa	MoA	1987	32,000	1,000
South Mujib	Karak	MoA	1980	976	400
Lajjoun	Karak	MoA	1981	1,100	1,100
Nakhil	Karak	MoA	1987	900	600
Desertification Project	Karak		1989	5,000	600
Twana	Tafila	MoA	1981	2,000	1,300
Fujeij	Ma'an	MoA	1958	1,000	400
Menshiah	Ma'an	MoA	1968	300	200
Aishiah	Ma'an	MoA	1981	1,000	750
Ras Al-Naqab	Ma'an	MoA	1986	1,200	900
Mudarawah	Ma'an	MoA	1992	2,000	300
Rajib	Ajloun	MoA	1983	4,500	600
Bilal	Ajloun	MoA	1991	1,700	700
Faysaliah	Ajloun	MoA	1992	2,000	600
Ira & Yarqa	Balqa	MoA	1986	4,000	1,600
Ma'in	Madaba	MoA	1983	2,000	1,200
North Mujib	Madaba	MoA	1988	1,000	500
Lajjoun	Karak	JCO	1983	1,500	1,500
Menshiah	Ma'an	JCO	1982	300	140
Ail	Ma'an	JCO	1988	262	112
Qureen	Ma'an	JCO	1982	1,500	731
Al-Sahin	Balqa	JCO	1992	2,300	200
Ma'in	Madaba	JCO	1980	3,500	3,200
Thaiban	Madaba	JCO	1980	375	210
Bani Hamada	Madaba	JCO	1987	1,500	470
Salia	Madaba	JCO	1987	1,500	300
TOTAL AREA				81,018	22,463

Source: Tadros (1992), Nahleh (1993), Shahwan (1994)

24. The existing Range Reserves (see Table A2.3) cover less than 1% of the total area of rangeland in Jordan (IFAD, 1993). Within the Reserves, some 28% of the land has been planted with forage shrubs in an attempt to improve grazing conditions. Most of these Reserves have some degree of protection and/or control over grazing practices, either through perimeter fencing or guards and a measure of co-operation with local pastoralist communities. The Reserves managed by the JCO have a better record in the latter regard.

25. The majority of existing Range Reserves are located in western Highland and Steppe areas, with few in the arid Badia (see Figure A2.5). A number of additional Range Reserves have been proposed, including several of large area in the Badia, but it is not clear when these might be established.

26. The existing Nature Reserves (see Table A2.4) also cover less than 1% of the total area of rangeland. Most of these Reserves are totally protected from grazing, either through perimeter fencing or guards, although in some areas, such as the Dana Reserve, local pastoralists still use areas within and immediately adjacent to the protected area.

Table A2.4: Nature Reserves in Jordan

Reserve Name	Location	Year Established	Area (ha)
Azraq Desert Reserve	Azraq	1987	32,000
Azraq (wetland)	Azraq	1977	1,200
Shaumari	Azraq	1975	2,200
Wadi Mujib	Madaba-Karak	1987	21,200
Zubia	Ajloun	1988	1,300
Dana	Tafila	1989	15,000
Wadi Rum	Aqaba	1989	56,000
TOTAL AREA			72,900

Source: MMRAE (1991)

27. The distribution of existing Wildlife/Nature Reserves is also biased towards the west, but has some representation in the arid Badia (see Figure A2.6). A number of additional Wildlife Reserves have been proposed, including several of substantial size in the Steppe and the Badia, but it is not clear when these might be established.

28. Data on plant species composition and biomass in Range Reserves have been collected by professional staff at the National Centre for Agricultural Research and Technology Transfer (NCARTT), summarised by Tadros (1985), and by technical staff in the Range Division of the Ministry of Agriculture, summarised by Shahwan (1994). The latter datasets are generally less quantitative in nature. As noted by IFAD (1993) and confirmed by the Mission, *'reports on rangeland forage biomass production are based on generalised values, quoted without reference to the original source and it appears that most of the values reported are based on estimates, rather than on actual measurements'*.

29. Representative estimates of average rangeland forage production provided by the IFAD (1993) mission for rangelands in the Steppe and Badia are given in Table A2.5. As noted in the IFAD report, these estimates are largely speculative, based on visual estimates, published but unattributed accounts and anecdotal reports from local herdsmen. These comments apply

equally to the hypothesised trends in biomass production for different livestock management scenarios (for example, see Figure 1 in the Introduction to the Main Report). While these speculations are useful for setting out possible outcomes under the proposed Development Programme, there is a clear need for empirical testing and/or validation of the assumptions leading to the construction of the models.

Table A2.5: Estimates of Average Rangeland Forage Production in Different Climatic Zones

Zone	Biomass Production (kgDM/ha)	
	Open range	Reserve
Highland	600	990
Steppe	100	450
Badia	40	150

Source: IFAD (1993)

30. In addition, since the estimates made or collected by the IFAD Mission were based on average values for a number of years, it is essential to understand the range of variation present in the rangeland systems of Jordan. It is interesting to note that the study of Tadros & Salem (1993) at Lajjoun in the Steppe reported biomass production values of 240 and 910 kgDM/ha, in open rangeland and Reserves respectively, in the spring of 1992, but values of only 20 and 190 kgDM/ha respectively in the spring of the following year. These results emphasise the temporal variability of plant production in the dry rangelands, and the danger inherent in relying on limited data or "average values" in assessing the productivity of the dry rangelands.

31. Taken together, both types of Reserve still cover a very small proportion of the total area of rangeland in Jordan. As noted by IFAD (1993), extrapolation of vegetation conditions, as estimated in protected Reserves, to more extensive areas of unmanaged rangeland is likely to be misleading. However, by virtue of the relative degree of control exercised over their land use, these areas have potential value as sites for providing baseline data on range condition in relation to soils and climate, and for regulated grazing experiments.

32. Descriptions of vegetation in Nature Reserves have been undertaken by ecologists working for the Royal Society for the Conservation of Nature. Reports are available on the vegetation of some of their Nature Reserves, while others are planned for the future. The RSCN is small, but well-organised and well-funded. Its administration has clearly defined divisions for resource assessment and monitoring, reserve management and education/extension/public relations (see Annex 1).

33. Unfortunately, few of the sources cited above have provided quantitative information on seasonal or annual variation in rangeland forage biomass production. It has been (correctly) suggested by IFAD (1993), that both seasonal and inter-annual variation in production is likely to be greater in the more arid Badia rangelands than in those of the Steppe and Highlands regions. In addition, the Steppe and Highland regions are thought to experience a bi-modal pattern of seasonal herbage production, with a major peak in the spring and a lesser one in the autumn, while in the Badia, production is uni-modal, with a single burst of productivity in the spring. Greater variation in the geographic pattern of forage production in the Badia is assumed from rainfall data (IFAD, 1993), and while this conjecture is also undoubtedly correct, there are no empirical data being collected on the actual patterns occurring on which to base management decisions.

34. National capacity for rangeland assessment, monitoring and research is limited. NCARTT has a capacity for research in rangelands, but this appears to be limited to one senior rangeland biologist of international experience (PhD at Utah State University, USA) and his associated technical staff.

35. The Range Division also has a very limited personnel complement, consisting of three senior staff at Headquarters in Amman, and a variety of technical staff in District Offices. The Head of Division has a PhD, taken at the Istanbul Forestry University, Turkey, and there is one Engineer with a diploma course in rangeland science (taken at the University of New Mexico, USA) and a Half-Engineer/technician, with training from the Arab Institute for Forestry and Range (AIFR) in Lazakia, Syria.

36. Technical staff in 24 District Offices of the Department of Forestry and Range are generally available, when necessary, for forage assessment and management activities in their local Range Reserves. In ten of these Districts there is a specific person, with basic forestry training, responsible for rangeland activities. The training of most such staff is undertaken at the AIFR in Syria or at the University of Mosul in Iraq. Occasionally there is additional training offered at other Universities or Institutes in the region, but there is a general problem when teaching is in foreign languages, such as French or English.

37. Most of the relevant staff in the Range Division are able to identify all plant species encountered in the rangelands. The Division has prepared a plant species list/dictionary for translation from Arabic to Latin nomenclature.

38. A programme for the Improvement of Agricultural Productivity in the Arid and Semi-Arid Regions of Jordan, performed jointly by the University of Jordan, NCARTT and a technical assistance team from Silsoe College, UK, has begun a four year programme of rangeland monitoring in the Steppe (University of Jordan, 1995). This programme will make estimates of rangeland composition and productivity at its study sites and will provide useful supplementary data for a nation-wide rangeland monitoring programme co-ordinated by PRIME.

39. The Faculty of Agriculture, University of Jordan, has a small number of competent lecturers and research staff in the field of rangeland ecology and management. There is one such lecturer at PhD level (University of Colorado, USA), who has innovative ideas concerning the development of a rangeland management curriculum, sets postgraduate students onto research in important areas of range ecology and is active in the preparation of reviews and assessments of the status of rangelands in Jordan (Juneidi & Abu-Zanat, 1993; Tadros *et al*, 1994).

40. The Jordan Badia Research and Development Programme is currently undertaking a series of studies, including interpretation of a variety of remote sensing images and the monitoring of vegetation and biodiversity in their study area in the Badia of north-eastern Jordan. The BRDP has developed good relations with local pastoral communities and has established an area of restricted grazing along the northern border with Syria, in an area used by the Badia Police as a camel grazing reserve.

41. Under the BRDP, the University of Durham's Centre for Overseas Research and Development has developed a research proposal for funding under the Darwin Initiative (UK) involving detailed studies of vegetation structure and dynamics in the arid rangelands of north-eastern Jordan. The BRDP has considerable input from researchers at overseas universities and

the Overseas Development Administration of the UK, as well as the participation of Jordanian counterparts at administration, biologist and technician level. Several Jordanian students are undertaking postgraduate research under sponsorship from the BRDP. Data on rangeland condition produced from the BRDP would be an additional and useful source of supplementary data for PRIME's proposed nation-wide rangeland monitoring and assessment programme.

REMOTE SENSING AND IMAGE PROCESSING

42. The NOAA satellite system receives reflectance data at several wavelength bands or receiving channels, which may be used in combination to calculate indices related to the cover and biomass of green vegetation. The Normalised Difference Vegetation Index (NDVI) is one such index which has been used extensively for rangeland monitoring (e.g. Tucker et al. 1983) although NDVI has some problems with differential reflectance by different background soil types and other indices have been proposed (see Appendix 1, and below).

43. A second satellite system, METEOSAT, has sensors which can detect the surface temperatures of clouds and weather systems. Indices estimating the duration of cold cloud temperature have been correlated with rainstorms and this system has been used to monitor the spatial distribution of estimated rainfall in a number of localities, including for example the Sahel in Africa (Snijders 1991).

44. The National Forecast Centre (NFC) at the Meteoroligcal Department has receiving equipment for both the NOAA and METEOSAT satellite systems. Images can be received on a daily basis and subjected to basic processing on site; this is generally restricted to the calculation of NDVI and the preparation of maps on a national scale. There is little or no archiving of the data; data tapes are held for a period, but eventually re-used. Up to the present, there has been no attempt to ground-truth the products from either the NOAA or METEOSAT systems in Jordan. The NFC has one Engineer with training in remote sensing at the University of Reading and the Natural Resources Institute, UK. In addition, there is a technician who assists in data collection.

45. The Royal Jordanian Geographic Centre (RJGC) has proven ability in processing Landsat-MSS and NOAA imagery. The RJGC is well funded and has both equipment, software and trained personnel equal to international standards. Their service includes both image processing and ground-truthing. The facilities and capabilities of the RJGC are described in more detail in Annexes 1 and 3.

46. It is important to consider how the data collected from rangeland and climate monitoring in ground-based sampling and remote sensing images could be integrated with other data. Data layers on climatic patterns, soils, topography and land cover are available through the JOSCIS database currently established in the Soils and Land Use Division of the Department of Forestry and Range. The SLUD has a GIS facility based on SPANS software, with technical staff partly trained in its use. A more complete description of the capabilities of the personnel and equipment of the SLUD can be found in Annex 3. For more complex integration and manipulation of remote sensing data with other data such as JOSCIS data layers, it would be possible to make use of the services of the RJGC.

RECOMMENDED RANGE ASSESSMENT AND MONITORING STUDIES

OVERVIEW

47. The overall objectives of the range assessment and monitoring component would be to assist the Jordanian authorities in establishing a baseline, quantitative description of forage vegetation conditions in the rangelands, with an analysis of past and current trends, and in developing a system for monitoring changes which occur under both climatic and human influence through management of livestock and croplands.

48. There is at present insufficient information concerning the dependence of forage productivity on climate, soils and topography (see Annex 3) on the one hand, and about the utilisation by livestock (see Annex 4) on the other. Equally, the ability of rangeland forage resources under existing conditions to support livestock remains almost completely unquantified. For assisting the planning of effective management interventions on a nation-wide scale, the existing descriptions of vegetation structure, productivity and dynamics would be extended in a monitoring programme of the rangelands of Jordan as a whole.

49. The Pastoral Resources Information Monitoring and Evaluation Unit (PRIME) would require a more detailed resources assessment than is possible from existing information, if it is to monitor changes that occur during the period of the Project. PRIME would also require a better understanding of these relationships in order to identify possible means of improving rangeland. Regular monitoring of rangeland vegetation composition and productivity would be needed to complement soils, land use and livestock population monitoring that would be carried out.

50. This would be achieved by using a combination of satellite remote sensing images and ground-based measurements of plant cover and composition. Remote sensing analysis is the most cost-effective method for assessing environmental conditions over large geographic regions, while ground-based examinations are necessary for directly determining the abundance of palatable forage plants and the suitability of rangelands for livestock.

51. The mapping of land suitability for cropland, rangeland improvement and unimproved extensive grazing of rangelands, as described in Annex 3, is an activity which would be improved by co-operative effort between the specialities of soil and land use survey and rangeland vegetation study. In particular, the land suitability criteria described in Table A3.4, which are physical and chemical soil properties and topographic features, need to be linked to data on vegetation productivity. This exercise would be a calibration and validation of the suitability criteria, which would allow realistic evaluation of land capability.

52. Through PRIME, technical assistance in rangeland assessment and monitoring through ground-based study and remote sensing techniques would be provided. Training in skills needed for rangeland monitoring and data analysis would be provided through technical assistance and short courses and Jordanian rangeland specialists would be encouraged to participate in applied research activity. Facilities in Jordanian institutions would be strengthened to enable them to provide such training opportunities.

53. In general, the studies described below are designed to provide a baseline level of information in the stages of the Project. It is at this stage that most input of technical assistance would be provided, in order to set up monitoring programmes and to train Jordanian personnel

in the methods required for their subsequent operation. It is expected that the core technical staff of PRIME would play a guiding role through the provision of technical assistance, as and when required, during PY 2-5.

A). TRENDS IN NATION-WIDE VEGETATION COVER AND CROPLAND EXTENT

Objectives

54. To develop an understanding of the trends in native vegetation cover and the extent of croplands in the rangelands on a nation wide basis over the past two decades and forward through the course of the Project term. The intention is to test the assumptions that there has been a steady trend of decreasing productivity and increasing cropland in the Steppe and Badia rangeland regions.

Proposed Study and Methodology

55. The study would produce estimates of the area of ground in different rangeland types and geographical regions of Jordan covered by productive native vegetation and by croplands during the spring growing season of several different years during a timespan covering the last 15-20 years. To achieve this, there would be an analysis of satellite images from the earliest available date, through to the present and on during the course of the Project.

56. The Landsat-MSS satellite system began collecting images in 1979, with data potentially available in each year since then. The proposed analysis would require the purchase of a full set of Landsat images, numbering seven in total, of the whole country in spring of each year for four dates: the beginning of the Landsat series (1979); midpoint between beginning of the series and the first year of the Project; PY1; and PY3 or PY5, depending on the duration and timing of Project implementation.

57. The precise years chosen for examination would be selected, when possible, on the basis of annual rainfall, such that each year would have roughly comparable rainfall amounts. This effort would be intended to control for the short term effects of rainfall on rangeland productivity, in order to examine longer term trends under the assumed influence of livestock impact.

58. The image signatures of productive rangeland ground cover and of cropland will be determined by ground-truthing exercises undertaken by teams composed of staff from RJGC, the Range Division, and SLUD, as described under item C) below.

59. Analysis of images used in the study would be carried out in PY1 and PY3/5. In PY1, images for the two dates in past and for the current year would be analysed, while in the final year of the Project, a single set of images for the current year would be examined for the final dataset. The analysis would be performed by the RJGC, with initial Technical Assistance by a Remote Sensing Specialist. Images for PY1 and PY3/PY5 would be purchased under the Ground Truthing study C) described below, while earlier historical images would be purchased under this Project component.

Timing and Cost

60. The estimated total cost of this component is US$ 43,493 and this is detailed in Annex 5; this would be encountered in PY1, when the system would be set up under short term Technical Assistance and the historical Landsat images would be purchased. Processing costs

for the historical images would be borne by this component in PY1, while processing costs in PY3/ PY5 would be borne by the Ground Truthing Study C), below.

Table A2.6: Estimated cost of "Trends in Nation-wide Vegetation Cover and Cropland Extent" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
43.5	0	0	0	0	43.5

B). SEASONAL PATTERNS OF RAINFALL AND RANGELAND VEGETATION COVER

Objectives

61. The proposed study's primary aim would be to follow the time course of rangeland vegetation production in different vegetation types, in relation to rainfall patterns on a spatial scale. This would allow the description of short term responses of vegetation in different rangeland types to immediate rainfall events, indicating which areas of rangeland remain productive and which appear to be suffering from a decline in productive capacity. It would feed into the land suitability mapping process described in Annex 3 and would provide a backdrop for evaluating the distribution, movement and rangeland utilisation patterns of livestock described in Annex 4.

Proposed Study and Methodology

62. The study would involve using images from the METEOSAT (for estimating rainfall distribution patterns) and NOAA/AVHRR (for estimating vegetation biomass production) satellite systems respectively. Details of satellite image data processing and interpretation are given in Appendix 1, but are summarised below.

63. The NOAA satellite system receives reflectance data at five wavelengths or receiving channels. Data from a combination of channels retrieved from NOAA satellites may be used to calculate indices which are related to the cover and biomass of green vegetation in the areas surveyed (See Appendix 1 for details).

64. One such index, the Normalised Difference Vegetation Index (NDVI), as been used widely with varying degrees of success, but is often confounded by differential soil reflectances; another index, the Global Environment Monitoring Index (GEMI) has been proposed to minimise these difficulties (Flasse & Verstraete, 1994). While the images produced may have low spatial resolution, in the order of 1 x 1 km, they have the advantage over other satellite products of high temporal repeatability, i.e. there is generally a pass overhead every day, as compared to one every 16-18 days for Landsat and SPOT. Empirical testing and validation of NOAA satellite indices is necessary to determine their applicability to local conditions.

65. The METEOSAT satellite system has sensors located in geostationary orbit which can detect the surface temperatures of clouds and weather systems. Clouds with a surface temperature of less than a threshold value (approximately -40°C) are more likely to be rain-bearing than those with higher cloud-top temperatures. The particular threshold temperatures associated with rain-bearing clouds and the quantity of rain they deposit varies temporally and spatially, and thus must be established empirically (Snijders, 1991). The spatial distribution of

rainfall would be estimated by the Cold Cloud Duration (CCD) index from Channel 2 of METEOSAT.

66. Initial calibration and subsequent validation of the products from METEOSAT and NOAA would be carried out under item C) described below.

67. METEOSAT and NOAA data are received on a daily basis at the National Forecast Centre, Meteoroligcal Department (NFC). It is proposed that METEOSAT and NOAA data would be collected and archived every day during the primary growing season, from January to May, of each Project Year. The NOAA-14 satellite is now the one of choice and it passes overhead Jordan every day in the early afternoon, which is considered ideal for NDVI greenness estimation. For the remainder of each year, NOAA data would be collected for one dekad (10 day period) per month. Since there is little or no rainfall outside the growing season, METEOSAT data for this period would not be needed, but could be archived, for possible later use.

68. Preliminary analysis would be completed at the NFC and further analyses and integration with other data layers would be completed at the RJGC. Technical assistance to establish and supervise the data collection and analysis process would be provided by a Remote Sensing Specialist. In return for the provision of data and analyses, institutional support would be provided by the Project to the NFC and the RJGC.

69. The data on spatial distribution of productivity estimates would be made available through PRIME to the Project teams working on land suitability mapping (see Annex 3) and livestock distributions (see Annex 4).

Timing and Costs

70. The study activities would be carried out in each year of the Project, from PY1 to PY5, with the input of specialist Technical Assistance for two months in PY1. Co-ordination and monitoring of progress in subsequent Project Years would be carried out by core staff of PRIME. The estimated costs would be US$ 33,600 and are detailed in Annex 5.

Table A2.7: Estimated Cost of "Seasonal Patterns of Rainfall and Rangeland Vegetation Cover" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
30.7	0.7	0.7	0.7	0.7	33.6

71. The NFC would receive institutional support in the form of additional computers and data storage equipment (magneto-optical disk drives), as well as backup equipment for the NOAA receiver. RJGC data processing would be paid for at their standard charge-out rates (See Main Report).

C). GROUND-TRUTHING OF LANDSAT-MSS AND NOAA IMAGES

Objectives

72. The studies of vegetation cover and range condition described above for determining a) long term trends and b) seasonal patterns, use Landsat and NOAA satellite remote sensing systems. In order for satellite-based monitoring to accurately reflect conditions of vegetation cover on the ground, it would be necessary to undertake substantial ground-truthing and continued validation exercises in all the major vegetation and land region mapping units.

Proposed Study and Methodology

73. Ground-truthing of Landsat and NOAA would involve initial identification of soil colour and albedo classes influencing the reflectance characteristics of the images. Field work would comprise polygon mapping of homogeneous soil class, vegetation cover and land use types in different areas of Jordan, using Global Positioning System (GPS) receivers to determine precise geographic locations to link with pixel identification on images. Areas for investigation would be chosen to include representative areas from Land Regions (Table A3.2), soil albedo types and vegetation zones as defined in previous studies. The precise number of sites required for field visits would be established at the very outset of this study.

74. There would be three field teams, each composed of one staff member from each of the Range Division and the Soil and Land Use Division, both of the Department of Forestry and Range in the MoA, and from the RJGC. For initial truthing of images, operations would be conducted for one month in both of the spring and late summer/early winter of PY1. For subsequent validation of Landsat images, field operations would be undertaken for 18 days in the spring of PY3 or PY5, while for validation of NOAA images, such field studies would take place in the spring of each year of the Project. Field data collection would include brief descriptions of dominant vegetation cover types and estimates of percentage ground cover of green vegetation and all vegetation, and plant biomass in broad classes.

75. Attempts would be made to undertake nested sampling. For Landsat-MSS calibration, where pixel size is on the order of 80 x 80m, smaller polygons would suffice. Clusters of such polygons would be combined to provide estimates of vegetation characteristics for the larger pixel size, 1000 x 1000m, on NOAA images.

76. Data processing would be executed by the RJGC, and technical assistance in setting up calibration and validation exercises would be provided by a Remote Sensing Specialist.

Timing and Costs

77. The studies would be undertaken in each year of the Project. The initial calibration activities would be more intensive in PY1, with field visits in the spring and autumn and two full sets of Landsat images purchased. Specialist Technical Assistance in setting up the analysis system would be provided at this time. In each of PY2 to PY5, the activities would be at lower intensity, with field exercises in the spring only and co-ordination of work by PRIME core staff. The estimated costs would be US$ 158,525 and are detailed in Annex 5.

Table A2.8: Estimated Cost of "Ground-Truthing of Landsat-MSS and NOAA Images" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
81.0	19.4	19.4	19.4	19.4	158.5

D). GROUND-TRUTHING OF METEOSAT IMAGES

Objectives

78. The studies of seasonal patterns in rainfall described in B) above employ the tools of the METEOSAT satellite remote sensing system. In order for satellite-based monitoring to accurately reflect rainfall conditions on the ground, it would be necessary to undertake initial ground-truthing and continued validation exercises.

Proposed Study and Methodology

79. Ground-truthing of METEOSAT images would involve correlation of predicted rainfall from Cold Cloud Duration data with matching data from geographically referenced rainfall stations, supplied by the Meteoroligcal Department. Initially, it would be necessary to estimate appropriate threshold values for CCD from a preliminary dataset of rainfall events during the spring of the First Project Year. This threshold value would then be tested and refined with additional data collected in the same and subsequent years.

80. Data analysis would be executed by the RJGC and technical assistance would be provided by a Remote Sensing Specialist.

Timing and Costs

81. Studies would be undertaken in each year of the Project, but as with the calibration of the Landsat and NOAA imagery, there would be specialist Technical Assistance in setting up the analysis system in PY1, and less intensive validation exercises in each of PY2 - PY5, under the co-ordination of PRIME core staff. The estimated costs would be US$ 40,870 and are detailed in Annex 5.

Table A2.9: Estimated Cost of "Ground-Truthing of METEOSAT Images" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
33.6	1.8	1.8	1.8	1.8	40.9

E). MONITORING OF VEGETATION SPECIES COMPOSITION AND BIOMASS

Objectives

82. Satellite-based monitoring methods are necessary for cost-effective coverage of large areas of land. However, such remote methods alone cannot provide detail on plant species composition and biomass production, and these are the sorts of data required for an assessment rangeland suitability for livestock grazing. To gain an understanding of the condition of rangeland herbaceous vegetation and its potential for growth and recovery, it would be necessary to undertake a broad scale survey of rangeland vegetation by making measurements at a network of sites on the ground. These data would allow an independent appraisal of existing maps of rangeland vegetation, and would provide an additional check on the ground-truthing of remote sensing indices.

Proposed Study and Methodology

83. Sampling sites would be selected, with the technical assistance of a Soils Specialist, from the sample sites in the Level 1 Soil and Land Use Survey. There are 11,717 sites in the reconnaissance survey and details of the soils, topography and simple vegetation cover

observations are stored in the JOSCIS database. Selection of sites would involve examining the JOSCIS database at SLUD. Stratification criteria would include soil colour and albedo classes, Land Regions (Table A3.2) and vegetation association types from the existing maps produced by HTS & SSLRC (1991) and FAO (1991), as well as a representative geographical spread.

84. Sampling would be widespread in the first year, with approximately 3,000 sites envisaged, but it is expected that there would be a reduction in sampling intensity (number of sites visited) in subsequent years, contingent on a statistical analysis of similarity between sites. Field work would take place for one month during the spring, with the timing chosen to coincide with peak biomass, allowing for significant vegetation growth and/or flowering, but to precede intensive grazing by livestock. This would probably be during February to March of any given year. The sites chosen in the first year, or a subset of them, would be revisited in subsequent years. Notes of distinguishing landmarks should be made, combined with the use of a GPS receiver, so as to allow return to the same location.

85. Sample plots would be chosen by driving to the site indicated by geographical co-ordinates on the GPS and identifying the target classes of soil type, topography and vegetation type. The specific plot location would be chosen by a random process involving a table of random numbers for determining the distance and direction of the sampling transect.

86. The most appropriate sampling method for estimating the composition and biomass of herbaceous and low shrub vegetation should strike a balance between precision and repeatability against the need for quick coverage of a large area of land. The method proposed below is given as a guide, but it is expected that modifications could be made, as deemed appropriate after initial exploratory sampling.

87. The basic sampling unit would be a transect 100m long delineated with a steel measuring tape, with 1 x 1 m quadrats spaced at 5 m intervals along it. The frequency of all plant species present in each quadrat would be noted. A visual estimate of total standing biomass would be made for each quadrat and every tenth quadrat would be clipped for subsequent weighing to calibrate the visual estimates. A number of such transects, running in parallel at 5m intervals, would be measured at each site; the number of transects required would be determined after initial sampling indicated the degree of variance between quadrats.

88. Modification of this basic method could involve changing the size of quadrats, or the spacing between quadrats and transects, dependent upon the nature of spatial pattern in the vegetation.

89. Soil samples would be collected for subsequent seed germination studies to determine the potential for rangeland recovery. The samples would be placed in germination trays at the Range Division Headquarters, given water and sunshine and monitored for the appearance of different plant species as an indication of regeneration potential at each given site.

90. The field effort would involve staff from the Range Division and Soils and Land Use Division of the MoA. It is envisaged that six teams of two technicians, one each from the Range Division and SLUD, would go out on field sampling during the one month period. Data processing for analysis of species composition and biomass at sampling sites would take place in the Range Division, and technical assistance would be provided by a Rangeland Management and Monitoring Specialist.

91. The results would be entered into a GIS for analysis of spatial patterns and correlation with other data sources. The existing vegetation patterns would be compared to vegetation maps produced in previous studies; these would be modified where necessary. The data would be further analysed by multivariate techniques in an exploration of the determinants of vegetation composition and biomass in relation to abiotic factors (climate, topography, soils) and intensity of grazing pressure, as indicated by livestock-based studies (see Annex 4).

Timing and Costs

92. Studies would be conducted in each year of the Project for one month in the spring. Activities in each year would be the same, with the possibility that fewer sites would be visited in PY2 to PY5. The services of a Range Management and Monitoring Specialist would be provided in PY1 and subsequent co-ordination of Jordanian personnel in the Range Division would be provided by PRIME core staff. The estimated costs would be US$ 82,940 and are detailed in Annex 5.

Table A2.10: Estimated Cost of "Monitoring of Vegetation Species Composition and Biomass" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
56.3	4.2	4.2	4.2	4.2	82.9

F). DEVELOPMENT AND REFINEMENT OF MODELS OF FORAGE BIOMASS PRODUCTION

Objectives

93. Decision makers should be provided with forecasts of rangeland forage productivity to allow the planning of interventions, when and where they are most needed. Such a forecasting system could be developed, based on data on rainfall distributions, using rainfall station and METEOSAT data, in combination with soils and landscape data. The intervening calculations would require the development of models of the relationships between rainfall, soil moisture and plant growth. It would be necessary to validate predictions from these models in their initial development against estimates derived by other, more direct methods. The predictions of seasonal changes in vegetation cover from rainfall patterns could be compared to the estimations of productivity made from data provided by the NOAA satellite system.

94. The refinement of land suitability criteria, as described in Annex 3, would also benefit from the development of models linking measurable soil and topographic characteristics to rangeland productivity.

Proposed Study and Methodology

95. Predictive models of rangeland plant biomass production related to rainfall, soil moisture and soil water balance have been developed for arid, semi-arid and temperate rangelands on several different continents, for example Australia (McKeon *et al.*, 1982), Africa (Coughenour *et al.*, 1990) and Europe (Seligman & van Keulen, 1989). Similar models would be developed from data collected at selected field study sites in Jordan. These sites would need protection from disturbance by people and livestock during the growing season, and would ideally have associated technical staff involved in ongoing research programmes.

96. Such sites may include the Jordan Badia Research and Development Programme, the University of Jordan/NCARTT Drylands Development Project, a selection of Range Reserves

managed by the Range Division of the MoA, and Nature Reserves managed by the Royal Society for the Conservation of Nature. Some 5-10 sites would be selected so as to include examples of the major rangeland types, balanced against practical considerations of accessibility and protection of the experimental equipment.

97. The studies would collect rainfall data, soils and hydrology data, and vegetation biomass production at study sites during the spring of each year. The measurement of plant production would involve clipping and weighing samples of rangeland vegetation protected from grazing during a single season by small, temporary, 1 x 1 x 1m, exclosure cages. In subsequent years, the cages would be moved within the same general area. Some 100 exclosure cages are envisaged, allowing repeated sampling of up to 20 replicates at individual sites.

98. Data would be analysed by the collaborating organisations and co-ordinated from PRIME and the Range Division of the MoA. Predictive mathematical relationships would be developed between vegetation production and soil water balance. These relationships would be integrated in the PRIME GIS data on topography, soil characteristics and rainfall (from the Meteorological Department sampling system or from METEOSAT) and would be applied to forecasting forage production. In co-ordination with the technical assistant Soils and Land Use Specialist and the SLUD, the land suitability classification system for rangeland forage productivity would be revised.

99. At this stage there should be close co-ordination between this component and the pedological study of Soil Water Balance described in Annex 3. Technical assistance would be provided by a Rangeland Management and Monitoring Specialist in the first year of the Project and the refinement of the models would be co-ordinated by core staff of PRIME in subsequent years.

Timing and Costs

100. Since this component is an experimental study, rather than the collection of baseline data, its activities would begin in PY2, when the bulk of the activities would be carried out, followed by subsequent refinement in each of PY3 to PY5. The services of a Range Management and Monitoring Specialist would be provided to assist in setting up the study in PY2 and co-ordination of activities in PY3-PY5 would be carried out by PRIME core staff. The estimated costs would be US$20,304 and are detailed in Annex 5.

Table A2.11: Estimated Cost of "Development and Refinement of Models of Forage Biomass Production" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
0	19.0	0.4	0.4	0.4	20.3

G). PILOT REGULATED GRAZING EXPERIMENTS

Objectives

101. The need to estimate suitable stocking rates for rangeland recovery and future sustainable use is a key theme in the Programme Formulation Report (IFAD 1993). Desirable stocking rates for livestock have been approximated by analytical methods based on the balance between estimates of average consumption and production rates, but to for practical use these methods require empirical validation. An effective technique would be to undertake experimental grazing trials, holding livestock at a range of known densities for the length of the growing season over a number of years and observing the response of the vegetation.

Proposed Study and Methodology

102. The study would involve measurements of the response of vegetation cover and productivity to different controlled livestock grazing intensities, for example 'low", "moderate" and "high", based on the observed range in densities on pastures in Jordan. A small number of pilot studies could be undertaken at selected Range Reserves and Nature Reserves, the Jordan Badia Research and Development Programme and other sites where the relevant management institution is interested in co-ordinating their efforts, and where relations with local communities allow exclosures and controlled stock densities. In such cases, where study sites are not on land managed directly by the GoJ, technical and financial arrangements would be made with the responsible institution over subcontracting duties of the Study.

103. The studies would involve the setting of different grazing regimes, within fenced exclosure plots, and monitoring the effects on the vegetation. It is proposed that the studies be initiated as pilot experiments, to demonstrate the methodology. If successful, similar studies could be initiated as part of ongoing programmes under the Range Division in Range Reserves, by the RSCN in selected Nature Reserves and at specific research sites, such as the BRDP at Safawi. This research programme could also be expanded under the Development Programme.

104. The basic methodology would be to establish a fenced hectare plot, which would be protected from grazing by livestock. A full-time guard would be needed to ensure that livestock did not enter the plot at any stage during its period of observation - this could be for several years. Good relations with local pastoralist communities would be helpful in this respect; this would suggest ungrazed portions of successful Range Reserves managed by the Range Division or the JCO, Nature Reserves managed by the RSCN, or sites within the BRDP study area. The sites chosen for the experiment would be representative of key vegetation communities of interest to government and private sector decision makers, with some background of information from earlier and ongoing studies of forage production dynamics under the Project or other current research/ study programmes.

105. The grazing regimes would be defined, ranging from no grazing, through moderate, to intense levels. At this stage, three grazing intensity levels would probably suffice to give an initial idea of the processes involved. Various combinations of grazing pattern, as practiced in Range Reserves, could be attempted, but it is probably most straightforward to allow a controlled sheep density into the paddock for the duration of the grazing season, so as to mimic normal pastoralist practices. For the purposes of the Pilot Study, 30 fenced exclosures are envisaged, clustered so as to allow for ready access and ease of protection. Five full-time guards are planned for under the current budget.

106. The methods for measurement of vegetation response would be the same as for the survey of rangeland composition and biomass, study E) described above. The field measurements and data analysis would be made by staff of the appropriate participating institution, whether it is the Range Division, JCO, Range Division or BRDP. The services of a Rangeland Monitoring Specialist would be provided to assist in the initial phase of setting up the exclosure and monitoring system.

Timing and Costs

107. It is proposed that the study plots be established during PY4 and monitoring continued in PY5, with the potential for being carried onwards if it is considered appropriate. The estimated costs would be US$ 44,458 and are detailed in Annex 5.

Table A2.12: Estimated Cost of "Pilot Regulated Grazing Experiments" Study (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
0	0	0	36.9	7.5	44.5

H). TRAINING CONSIDERATIONS

Objectives

108. The capacity of Jordanian institutions, particularly the Range Division, to carry out rangeland monitoring is limited at present and needs to be strengthened.

Proposed actions

109. This building of capacity would be achieved through training of nominated personnel, both in short courses for technical staff on range management and research methods at local institutions, and short term refresher programmes in rangeland management and ecology for professional staff at overseas universities.

110. Support would be given for curriculum development and the establishment of a range management course at the University of Jordan. The Faculty of Agriculture has lecturers in rangeland management and dry land agriculture on its staff, but lacks a structured formal programme of rangeland studies. It is envisaged that the project would support the formation of a curriculum development committee, comprising representatives of the Faculty of Agriculture, NCARTT, Ministry of Agriculture, Department of Forestry and Range, HCST, RJGC, ICARDA and ACSAD to prepare an appropriate range management programme, catering for the needs of undergraduates, postgraduates and diploma course students.

111. It is felt that a variety of existing staff members of the Ministry of Agriculture would benefit from refresher courses in range resource management and assessment. The distinction between an arid land forester and a rangeland specialist is also considered to be somewhat esoteric and artificial in the Jordanian context. Much would be gained in time, money and flexibility, if the more numerous cadre of foresters were offered conversion courses in range management.

112. Since the Range Division has relatively few staff members with training beyond a very basic level, it would appear that there is a need to augment the capacity at both the higher planning and supervisory level, and at the level of field survey and management personnel. The

former would be relatively few, perhaps some four individuals who are already in the Ministry, or who may be recruited, and these could benefit from a brief period of four month of overseas training. The latter group would be more numerous and would require a basic introduction to rangelands, which could be provided locally at the University of Jordan.

Timing and Costs

113. The training would take place during all years of the Project. PY1 would focus on Curriculum development at the University of Jordan, establishing the capacity for training of Ministry of Agriculture staff in the principles and basic practice of rangeland monitoring and management. In PY2 - PY5, there is provision for 80 man months per year of local training. In PY2 - PY4, four man months of overseas training.

114. The estimated cost of proposed training is US$ 159,200 and is detailed in Annex 5.

Table A2.13: Estimated Cost of Training in Rangeland Management and Research Methods (US$ 1000s)

PY1	PY2	PY3	PY4	PY5	Total
25.0	38.6	38.6	38.6	38.6	159.2

TERMS OF REFERENCE FOR RANGE ASSESSMENT AND MONITORING STUDIES

115. Outline Terms of Reference for the proposed studies are set out below. It is emphasied that these are for illustrative purposes only. Where appropriate, details are included regarding the personnel which would be recruited on a long term basis.

A). TRENDS IN NATIONWIDE VEGETATION COVER AND CROPLAND EXTENT

116. Beyond anecdotal accounts, there is little quantitative evidence of the scope and rate of change in the extent of native rangeland vegetation cover and the spread of cropland into areas of grazing land. To place the present condition of the rangelands in context and to establish a baseline for monitoring of future trends, it is necessary to look at the available historical data on vegetation cover on a nationwide basis. The Landsat-MSS image series, which began in 1979, offers the most cost-effective source of this type of information.

Study Requirements

117. The requirements of the study are:

- To identify suitable Landsat images for examination, based on the criterion of annual rainfall regimes, with selection of similar years as to control for climate as a source of variance.
- To procure the digital tapes for the selected years and to make them available to the RJGC for processing.
- To ensure that RJGC staff are clear on the approach to take and the type of data to collect and that MoA Range Division staff are clear on the interpretation of trends in the data.
- To produce a set of quantitative estimates of natural rangeland plant cover and cropland extent on a nationwide basis across a span of 15-20 years.

118. Funding would be provided to purchase the Landsat-MSS digital images required. Technical assistance would be provided by a Remote Sensing Specialist consultant, whose qualifications are described below, for one month at the outset of the study in order to clarify the methodology of Landsat-MSS image processing and time series analysis to RJGC staff.

119. It is anticipated that 120 man-days would be required in PY1 to complete the necessary processing of two full sets of archived, historical Landsat images -- processing of contemporary images would be undertaken under the ground-truthing study (see C) below). Existing or recruited staff at the RJGC would be expected to undertake the bulk of the image analysis work. Work on the analysis by RJGC would be paid for on a cost-recovery basis at their standard charge-out rates.

120. The staff required at the RJGC for remote sensing image processing would be at least one officer, and preferably two to ensure continuity of work activity, with MSc or equivalent qualification and at least five years of practical experience.

121. There would be co-ordination and, when necessary, supervision of the image processing throughout the Study by the Senior Monitoring and Evaluation Officer and technical assistant Information/ Image Processing Specialist of PRIME. Assistance and

supervision of image interpretation in terms of trends in forage condition and land cover would be provided from the PRIME unit by the Range Management Officer and technical assistant Environmental Specialist. The information provided by the study would be made available to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation.

B). SEASONAL PATTERNS OF RAINFALL AND RANGELAND VEGETATION COVER

122. Monitoring of rangeland vegetation production requires the description of short term responses of vegetation in different rangeland types to rainfall, indicating which areas of rangeland remain productive and which appear to be suffering from a decline in productive capacity. Land suitability mapping for pastoralism and evaluation of the distribution, movement and rangeland utilisation patterns of livestock both require information on the spatial patterns of rangeland forage production over large land areas. Interpretation of images from the NOAA satellite is needed to support these requirements.

123. The collection and archiving of data from the NOAA-14 satellite would be undertaken by staff at the National Forecast Centre of the Meteoroligcal Department. Some image processing would be undertaken at the NFC, but the bulk of it would be completed at the RJGC.

Study Requirements

124. During the spring growing season of each year, from January to May, data from the NOAA-14 satellite would be collected on a daily basis by staff members at the NFC and stored on magneto-optical media. During the less productive times, from June to December, data would be collected for the first 10 days of each month.

125. The archived data would be passed to the RJGC, where staff members would calculate dekadal (10 day) maximum composited values of NDVI, GEMI and possibly other indices. Images in the series within a year would be examined for the appearance of non-productive patches and for the rate of appearance and disappearance of vegetation cover.

126. The processed images would be made available to other groups, such as the PRIME Livestock Monitoring Study Team and the Soils and Land Use Teams.

127. The staff required at the NFC would be a senior officer with at least an MSc qualification or equivalent training and 5 years experience in retrieval, storage and basic processing of NOAA and METEOSAT digital data; and a second, junior officer with at least BSC level training, who could be instructed in data collection and storage methods by the senior officer. The staff required at the RJGC for remote sensing image processing would be at least one officer, and preferably two to ensure continuity, with MSc or equivalent qualification and at least five years of practical experience, as for study A) above.

128. It is anticipated that one man-month of image processing would be required in each year of the Project. RJGC staff would undertake the bulk of the image analysis work, which would be charged for on a cost-recovery basis at their standard charge-out rates.

129. Technical assistance would be provided by a Remote Sensing Specialist consultant, whose qualifications are described below, for two months at the outset of the study in order to clarify the methodology of NOAA image interpretation to RJGC staff and to relevant staff of

the PRIME unit. In the first year and for the remainder of the study period, the data collection activities and analyses would be supervised and co-ordinated by the Senior Monitoring and Evaluation Officer and technical assistant Information/ Image Processing Specialist of PRIME.

130. Interpretation of the seasonal patterns of forage cover production would be guided and implemented by the PRIME unit's Range Management Officer and technical assistant Environmental Specialist. The Monitoring and Evaluation Officers of PRIME would ensure that the processed, interpreted images are stored in accessible format in the appropriate GIS and made available to any interested parties on request.

C). GROUND-TRUTHING OF LANDSAT-MSS AND NOAA IMAGES

131. Ground-truthing of the reflectance-based satellite products estimating the type and extent of vegetation cover is needed for the interpretation of the digital images and their translation into resources of practical value in rangeland monitoring.

Study Requirements

132. The output of this study component should be a reliable calibration of Landsat-MSS and NOAA remote sensing images with conditions of measureable rangeland vegetation cover.

133. A full set of Landsat-MSS images for Jordan should be purchased for the spring and autumn/ early winter of PY1 for the initial ground-truthing and for the spring of PY3 or PY5 for a subsequent validation exercise. NOAA-based images of NDVI or GEMI for the same seasons of PY1 for initial ground-truthing and for the each of PY2-PY5 for validation would be obtained from the NFC, with processing by the RJGC.

134. The three-person field teams (plus a driver) that would undertake the field-based portion of the ground-truthing work would be composed of one member each from the RJGC (team leader), Range Division and SLUD. There would be three such teams and each team would be expected to spend two months in the field in PY1 and 18 days in the field in each of PY2-PY5. Image processing and correlation of field data with imagery would be done at the RJGC.

135. Some 120 man-days of image processing for calibration of contemporary Landsat imagery are anticipated in PY1 and 60 man-days for validation of Landsat imagery in PY3 or PY5. Processing of NOAA images needed for calibration and validation would be covered under study B) described above. As for the image processing described in studies A) and B) above, work on this component by the RJGC would be charged for on a cost-recovery basis at their standard charge-out rates.

136. The qualifications required of RJGC staff are similar to those of studies A) and B) above. The staff members of the Range Division participating in the field exercises should have qualifications of at least BSc or equivalent and 5 years experience with rangeland studies in Jordan, including a thorough knowledge of plant species identification and biomass estimation methods and an aptitude for field work. The members of SLUD staff should have similar qualifications, along with a knowledge of land cover and land use types.

137. Technical assistance would be provided by a Remote Sensing Specialist consultant, whose qualifications are described below, for two months at the outset of the study in PY1 in order to clarify the methodology of ground truthing Landsat-MSS and NOAA images to RJGC, Range Division and Soils and Land Use Division staff. This work would involve

ensuring at the outset that the required field equipment is in place, that the planned sampling locations are representative of areas on the images and of known soil and topographic land units and that interpretation routines are appropriate and adequate.

138. In the first year and for the remainder of the study period, the data collection activities and analyses would be supervised and co-ordinated by the Senior Monitoring and Evaluation Officer and technical assistant Information/ Image Processing Specialist of PRIME. Interpretation of the calibration and validation land cover types and extent would be guided by the PRIME unit's Range Management Officer and technical assistant Environmental Specialist.

139. The information provided by the study would be made available to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation.

D). GROUND-TRUTHING OF METEOSAT IMAGES

140. Ground-truthing of the cold cloud duration index for estimating rainfall probability will be needed for the interpretation of the digital images and their translation into resources of practical value in predicting rainfall distribution..

Study Requirements

141. The output of this study component should be the reliable calibration of METEOSAT remote sensing images with measureable distribution of rainfall.

142. METEOSAT images for rainfall periods in the spring and autumn/ early winter of PY1 for the initial ground-truthing and for the spring of PY2- PY5 for subsequent validation exercises would be obtained from the NFC, with processing by the RJGC. Data on rainfall from selected stations in different areas of Jordan would be obtained from the Meteorological Department.

143. It is anticipated that RJGC staff will undertake the bulk of the calibration and verification analysis work; this would be charged for on a cost-recovery basis at their standard charge-out rates. Thirty man-days would be required in PY1 for initial calibration and 15 man-days in each of P2- PY5 would be required for validation. The staff required at the RJGC for remote sensing image processing and calibration would be at least one officer, and preferably two to ensure continuity of work activity, with MSc or equivalent qualification and at least five years of practical experience, as for studies A), B), C) and D) above.

144. Technical assistance would be provided by a Remote Sensing Specialist consultant, whose qualifications are described below, for two months at the outset of the study in PY1 in order to for two months in order to clarify the methodology of ground-truthing Meteosat images to RJGC staff. This work would involve selecting sample rainfall station sites at the outset, deciding on a reasonable, initial threshold temperature for cold cloud duration and outlining appropriate and adequate interpretation routines.

145. In the first year and for the remainder of the study period, the data collection activities and verification analyses would be supervised and co-ordinated by the Senior Monitoring and Evaluation Officer and technical assistant Information/Image Processing Specialist of PRIME.

146. The information provided by the study would be made available to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation.

E). MONITORING OF VEGETATION SPECIES COMPOSITION AND BIOMASS

147. Gaining an understanding of the condition of rangeland herbaceous vegetation and its potential for growth and recovery requires a broad scale ground-based survey at a network of sampling sites distributed across the main rangeland types and geographical regions of Jordan. Such a survey is also needed to provide a check on previously derived maps of rangeland plant communities and on satellite-based cover indices.

Study Requirements

148. The output of this study should be a baseline dataset describing the pattern of forage composition and abundance across the main land classification units and geographical regions of Jordan and a system for updating this dataset at periodic intervals through monitoring. The datset would be resident in a GIS, where it would be accessible for comparison with other sources of information on rangeland condition.

149. The two-person field teams (plus a driver) that would undertake the field-based portion of the survey work would be composed of one member each from the Range Division and SLUD. Leadership of each team would depend on the seniority and experience of the individuals involved. There would be six such teams in PY1 for baseline data collection and three teams in each of PY2-PY5 for repeated monitoring of the sampling sites. Each team would be expected to spend one month in the field during the peak of spring plant productivity (likely to be during February-March) in every year.

150. The staff members of the Range Division participating in the field exercises should have qualifications of at least BSc or equivalent and 5 years experience with rangeland studies in Jordan, including a thorough knowledge of plant species identification and biomass estimation methods and an aptitude for field work. The members of SLUD staff should have similar qualifications, along with a knowledge of land cover and land use types.

151. Data entry and processing should take place at the headquarters office of the Range Division, in possible conjunction with existing facilities, such as databases and GIS at SLUD. This work should be supervised by a Range Ecologist in the line staff of the Range Division, with assistance from PRIME staff where required.

152. The processed information provided by the study would be made available to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation.

153. Technical assistance would be provided by a Rangeland Management and Monitoring Specialist consultant, whose qualifications are described below, for three months at the outset of the study in PY1 in order to clarify the methodology of estimating species composition and biomass to Range Division staff. This work would include selecting some 3,000 initial sampling sites from the JOSCIS database and establishing in the Range Division and SLUD appropriate and adequate techniques for field data collection and for data entry, analysis and interpretation. The latter should incorporate provision for reduction of the sampling intensity based on similarity analysis of the baseline samples, such that the monitoring activities of PY2-PY5 can focus on a smaller number of key sites.

154. In the first year and for the remainder of the study period, the data collection activities and verification analyses would be coordinated by the Range Management Officer, Senior Monitoring and Evaluation Officer and technical assistant Environmental Specialist of PRIME.

The Unit's Monitoring and Evaluation Officers would make themselves aware of the field methods employed in data collection and would ensure that the processed data are stored in accessible format in the appropriate GIS and made available to any interested parties on request.

F). DEVELOPMENT AND REFINEMENT OF MODELS OF FORAGE BIOMASS PRODUCTION

155. A method for forecasting rangeland productivity from rainfall data would be of great assistance to decision makers in planning and implementing appropriate interventions for ameliorating poverty and promoting development in the rangelands of Jordan. Land suitability classification would also be improved with more quantitative information on the factors relationship between forage production and abiotic factors.

Study Requirements

156. This study, which is essentially experimental, would begin in PY2, since the first year of the Project would be spent in gathering baseline data on forage production and rainfall patterns across the extent of Jordan from satellite images and extensive ground-based surveys. Its expected output would be a set of mathematical formulations, or equations, relating forage production to estimates of soil moisture for different major soil classification zones within the the Kingdom.

157. Some 5-10 sites would be chosen for this detailed study. The sites chosen should represent samples of the major rangeland types and have detailed background data on soils and topography. There should be a basic logistical infrastructure which includes livestock grazing while protecting small temporary exclosures from disturbance for the length of a growing season. There should also be facilities for recording rainfall at or very near to the study sites. These criteria require that such sites are located in or adjacent to Government or JCO Range Reserves, Nature Reserves or study areas of other similar Projects.

158. It is anticipated that a two-person field team would undertake the field-based portion of the work, which would involve initial setting up of 100 small exclosures at the selected study sites before the growing season and returning to measure forage biomass production at the spring peak of productivity in March. Some 20 man-days per year for PY2-PY5 are foreseen.

159. In the Range Division, such a team would be composed of the senior range ecologist, and a field technician, who has at least BSc or equivalent and 5 years experience with rangeland studies in Jordan, including a thorough knowledge of plant species identification and biomass estimation methods and an aptitude for field work.

160. There would be some contracting out of the study activities to other research institutions when possible. Such institutions as the BRDP and the University of Jordan/NCARTT Drylands Development Project would be given the financial support to undertake the studies, including field data collection, supervision and analysis. The personnel of such institutions should have qualifications similar to those outlined for the Range Division staff.

161. Technical assistance would be provided by a Rangeland Management and Monitoring Specialist consultant, whose qualifications are described below, for one month at the outset of the study in PY2 in order to clarify the methodology of estimating forage biomass in the temporary exclosures to staff in the Range Division and co-operating institutions. This work

would include selecting sampling sites and establishing in the Range Division adequate techniques for data entry, analysis and interpretation. In the latter interpretation phase, the statistical techniques for developing models of the forage production process should be established and explained by the technical assistant.

162. In PY2 and for the remainder of the study period, the data collection activities and analyses would be coordinated by the Range Management Officer, Senior Monitoring and Evaluation Officer and technical assistant Environmental Specialist of PRIME.

163. The information provided by the study would be made avialable to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation. The Monitoring and Evaluation Officers of PRIME would make themselves aware of the field methods employed in data collection and would ensure that the processed data are stored in accessible format in the appropriate GIS and made available to any interested parties on request.

G). PILOT REGULATED GRAZING EXPERIMENTS

164. Rangeland rehabilitation and development requires knowledge, or at least estimates, of the relationship between livestock density and rangeland vegetation condition, and in turn on livestock productivity. A direct, experimental technique for evaluating the impact of different livestock grazing intensities on rangeland plant cover involves controlled grazing trials at different stocking rates at selected study sites over a number of years. The present study is intended to develop pilot experiments using this approach.

Study Requirements

165. This study would begin in PY4, after the data collected during the first three years had accumulated to allow the selection and placing into context of suitable study sites. Its expected output, which could take many years to achieve, would be quantitative data on the relationship between grazing intensity and rangeland condition in arid and semi-arid Jordan.

166. Some 5-10 sites would be chosen for this detailed study. The selection criteria would be similar to those for the Biomass Production Model study (see F) above). The sites chosen should represent samples of the major rangeland types and have detailed background data on soils and topography. There should be a basic logistical infrastructure and good relations with local pastoralist communities, which in combination would allow controlled livestock grazing while protecting the large permanent exclosures from undesirable disturbance for an extended period. There should also be facilities for recording rainfall and collecting other relevant data at or very near to the study sites. As for study F), these criteria require that such sites are located in or adjacent to Government or JCO Range Reserves, Nature Reserves or study areas of other similar Projects.

167. It is anticipated that a two-person field team (plus a driver) would undertake the field-based portion of the work, which would involve initial setting up of 30 large (1ha) exclosures (at least 3 replicates at different stocking rates) at the selected study sites and returning to measure forage biomass production at the spring peak of productivity in March. Some 3 man-months per year for PY4-PY5 are foreseen.

168. In the Range Division, such a team would be composed of the senior range ecologist, and a field technician, who has at least BSc or equivalent and 5 years experience with rangeland studies in Jordan, including a thorough knowledge of plant species identification and

biomass estimation methods and an aptitude for field work. Because it is of critical importance that the exclosures remain undisturbd, it would appear that some or all of the study sites would require full-time guards. Provision has been made in the Project budget for 5 such guards.

169. There would be some contracting out of the activities in this study to other institutions when possible. Such institutions as the BRDP and the University of Jordan / NCARTT Drylands Development Project would be given the financial support to undertake the studies, including field data collection, supervision and analysis. The personnel of such institutions should have qualifications similar to those outlined for the Range Division.

170. Data entry and processing should take place at the headquarters office of the Range Division, in possible conjunction with existing facilities, such as the databases and GIS at SLUD. This work would be supervised by the senior range ecologist of the Range Division, as described above. Results from studies by other institutions should also be collated at the Range Division. The information provided by the study would be made avialable to PRIME for integration with other data collected by the Project, and subsequent analysis and interpretation.

171. Technical assistance would be provided by a Rangeland Management and Monitoring Specialist consultant, whose qualifications are described below, for one month at the outset of the study in PY4 in order to clarify the methodology of measuring forage conditions in the permanent exclosures to staff in the Range Division cooperating institutions. This work would include selecting sampling sites, coordinating exclosure construction, organising the control of stocking rates and establishing in the Range Division adequate techniques for data entry, analysis and interpretation.

172. In PY4 and for the remainder of the study period, the data collection activities and analyses would be coordinated by the Range Management Officer, Senior Monitoring and Evaluation Officer of PRIME. The Monitoring and Evaluation Officers of PRIME would make themselves aware of the field methods employed in data collection and would ensure that the processed data are stored in accessible format in the appropriate GIS and made available to any interested parties on request.

TECHNICAL ASSISTANCE

Remote Sensing Specialist

Qualifications and experience required

173. The applicant will require a PhD or equivalent, and at least 10 years experience in agricultural or ecological monitoring using satellite-based remote sensing techniques, including imagery from the Landsat-MSS, NOAA and METEOSAT systems. Computer literacy in statistical analysis of substantial databases, Geographic Information Systems such as SPANS, ArcInfo and IDRISI, image processing software such as ERDAS and IDA, and data presentation techniques would be essential. Experience with UNIX-based operating systems and computer networking would be favoured.

174. As the ground-truthing exercises will require extensive field trips, proven ability in organising field data collection in remote areas is essential.

175. The candidate should have had some experience of supervising and training local staff to an advanced level. Fluency in spoken and written English is essential and a basic working knowledge of spoken Arabic would be helpful.

Tasks

176. In coordination with the Senior Monitoring and Evaluation Officer and the technical assistant Information / Image Processing Specialist of PRIME, he/she would assist the RJGC and the Range and Soils and Land Use Divisions in setting up procedures for accessing, analysing and ground truthing remote sensing images as described above in A), B), C) and D).

177. The technical assistance would be required in the First Year of the Project. The breakdown of this requirement by Study is given below.

Table A2.14 Timing of Technical Assistance by the Remote Sensing Specialist.

Study	PY1	PY2	PY3	PY4	PY5
A) Long term trends	1 month				
B) Seasonal patterns	2 months				
C) Truth Landsat, NOAA	2 months				
D) Truth Meteosat	2 months				

Range Management and Monitoring Specialist

Qualifications and experience required

178. The applicant will require a PhD or equivalent, and at least 10 years experience in rangeland or ecological monitoring in arid or semi-arid environments. An informed understanding of the interactions between grazing/ browsing herbivores and their habitats, particularly in non-equilibrium systems, is essential. Extensive practical knowledge of ground-based and remote sensing techniques for the study of rangeland forage condition would be required. Computer literacy in statistical analysis, mathematical modelling, GIS, image processing and presentation techniques is considered indispensable.

179. Familiarity with livestock in general and small ruminants in particular, and previous experience in the Middle East in the context of rangeland management, would be an advantage. Proven ability and enthusiasm for field data collection is essential.

180. The candidate should have considerable experience in supervising and training local staff to an advanced level. Fluency in spoken and written English is essential and a basic working knowledge of spoken Arabic would be an advantage.

Tasks

181. In coordination with senior staff members of the PRIME unit, namely the Range Management Officer and Senior Monitoring and Evaluation Officer and the technical assistant Environmental Specialist, he/she would assist officers in the Range and Soils and Land Use Divisions in setting up procedures for extensive surverys of vegetation condition, as described above in E), developing models of forage production F) and pilot regulated grazing experiments as described above in G).

182. The technical assistance would be required in the First, Second and Fourth Years of the Project. The breakdown of this requirement by Study Component is given below.

Table A2.15 Timing of Technical Assistance by the Rangeland Management and Monitoring Specialist.

Study	PY1	PY2	PY3	PY4	PY5
E) Vegetation survey	3 months				
F) Forage model		1 month			
G) Grazing experiment				1 month	

APPENDIX 1: REMOTE SENSING, GIS AND IMAGE PROCESSING REQUIREMENTS.

WHAT IS AVAILABLE IN JORDAN.

183. National Oceanic and Atmospheric Administration (NOAA) and METEOSAT receiving stations are available at the National Forecast Centre (NFC) of the Meteorological Department in Amman.

184. Internationally competent Geographic Information System (GIS) and remote sensing (RS) expertise is located at the Royal Jordanian Geographic Centre (RJGC).

PROGRAMME OBJECTIVES.

- A RS based monitoring system for Jordanian rangelands incorporating:
- Operational METEOSAT derived estimates of rainfall.
- A large scale ground truthing exercise using Landsat data to quantify land-use types and extents, as well as species compositions and biomass production estimates. It would be subsequently desirable to extrapolate backwards in time (using archived Landsat data) to investigate the rate of rangeland degradation and forward in time to monitor rangeland rehabilitation rates and thus Programme progress.
- Real time estimates of "greenness" are required to understand of the seasonal dynamics of the rangeland ecosystem. When calibrated by the above ground truthing exercise these data can give contemporary estimates of the land-use, biomass *etc.*, albeit at a coarser resolution. The lower spatial resolution (1 x 1 km) is the necessary compromise for having higher frequency data acquisition by the NOAA satellite.
- A substantial degree of operational independence from potential mechanical and political problems.

REMOTE SENSING BACKGROUND.

Vegetation indices.

185. Vegetation indices exploit the fact that plants absorb red light (AVHRR Channel 1) and whilst reflecting near infra-red (AVHRR Channel 2). Healthy vegetation will therefore look darker in the visible and brighter in the infra-red region than an unhealthy or dead vegetation. Early vegetation indices exploited this fact by using the simple ratio of Channel 2/Channel 1 reflectances, called the Proportional Vegetation Index or PVI. Later indices attempted to overcome the problem of reflectance from the (usually dark or reddish) soil background by dividing the difference between these two channels by their sum, to give the Normalised Difference Vegetation Index or NDVI. It is defined as follows:

$$NDVI = \frac{(Ch_2 - Ch_1)}{(Ch_2 + Ch_1)}$$

186. The NDVI has been widely used to predict vegetation biomass (Tucker *et al.* 1983), coverage (Tucker *et al.* 1985) and phenology (Justice *et al.* 1985) in a range of ecosystems and has proved especially useful in areas of sparse vegetation coverage, where they have a better dynamic range than the simpler vegetation indices such as PVI.

187. More recently, the Global Environment Monitoring Index (GEMI) has been proposed by Pinty and Verstraete (1992), again with the intention of reducing the variability introduced by the soil background and, in addition, of reducing atmospheric effects. Soil effects are minimised because, at least in theory, the GEMI gives a more constant index of vegetation activity against a much wider range of soil conditions than does the NDVI. GEMI was derived from first principles, rather than empirically, (although the physical basis for the index is not fully explained in the literature). It is defined as follows:

$$GEMI = \eta(1 - 0.25\eta) - \frac{Ch_1 - 0.125}{1 - Ch_1}$$

188. where

$$\eta = \frac{2(Ch_2^2 - Ch_1^2) + 1.5Ch_2 + 0.5Ch_1}{Ch_2 + Ch_1 + 0.5}$$

189. Initial application of GEMI to AVHRR data for Africa suggests a three-fold advantage over the NDVI. First, the GEMI is less sensitive to atmospheric variations; second, it has a much enhanced ability to detect clouds (which appear dark on both NDVI and GEMI but are more easily detected, and may therefore be more easily screened out, by GEMI); and finally, it has a higher dynamic range in xeric environments, showing details (*e.g.* of geological formations or land surface topology) in sparsely vegetated areas that are not visible in other imagery (Flasse and Verstraete 1994).

Land Surface Temperature indices.

190. Objects emit radiation in proportion to there temperature. Measuring this emitted radiation from space enables us to infer the temperature of the land, provided we can account for the effect of the intermediate atmosphere and the radiative properties of the objects being measured. Channels 4 and 5 of the NOAA satellite are used to account for atmospheric effects (principally caused by absorption of the radiation be water vapour). Absorption is greater in Channel 5 than in Channel 4 so the difference in the signal of these two closely spaced channels can be used to calibrate for water absorption. This simultaneous use of information from both channels to estimate surface brightness temperatures is described as a 'split window' technique, because it is performed within the same radiance window of the atmosphere.

191. Many "split window" techniques exist but Price (1984) is widely adopted and has been evaluated as accurate to ± 3 °C for a uniform tall grass prairie habitat in Kansas (Cooper and Asrar 1989). These relationships have also been shown to be robust in a range of habitat types and throughout the year on African data-sets (Hay 1993).

Rainfall estimates.

192. Clouds with a cloud-top temperature of less than a threshold value (of c. -40 °C) are more likely to be rain-bearing than those with higher cloud-top temperatures. These cloud-top temperatures can be recorded by the thermal infra-red Channel 2 of the METEOSAT satellite. The particular threshold temperature associated with rain-bearing clouds and the quantity of rain they deposit varies temporally and spatially and thus must be established empirically (Milford and Dugdale 1990). This has been done by the Tropical Applications in Meteorology of SATellite and other data (TAMSAT) program for the area of West Africa from the equator to south of the Sahara desert (Snijders 1991) and the results are now used by the African Real Time Environmental Monitoring and Information System (ARTEMIS) of the Food and

Agriculture Organisation (FAO), Rome, to generate dekadal and monthly images of Cold Cloud Duration (CCD) or the number of hours for which each pixel was covered by cold clouds during the compositing period.

HOW THIS CAN BE ACCOMPLISHED IN JORDAN.

Data acquisition.

193. All five AVHRR channels on the daytime NOAA satellite overpass are to be downloaded. The block images are scaled and co-registered with custom software (shipped with receiving systems). Future advice can be sought from Anita Perryman and Bob Harris, at NRI who have experience of installing and running receiving stations in Zambia. Block images are imported by a GIS, such as IDRISI, running on a modest PC. In Linux these should be DOS to UNIX converted, compressed and "tar" archived to a DAT tape or re-writable optical disc. These data can then be easily read on a UNIX workstation and be imported by UNIX based remote sensing software such as ERDAS Imagine or EASI PACE.

194. Accumulation of CCD data from 48 daily METEOSAT images. Daily data should be stored as accumulated CCD durations and 0.5 hourly data dumped. These would be stored and archived in the same way as the AVHRR imagery above. A potential expert consultant is Fred Snijders, FAO, Rome.

Data processing.

195. This would be done using a remote sensing package running on a UNIX workstation.. Programs necessary to produce PVI, NDVI, GEMI, as well as raw channel information and surface temperature measurements can be obtained from Trypanosomiasis and Land-use in Africa (TALA) research group, Department of Zoology, University of Oxford.

196. The products would then be archived to DAT tape on a daily basis and decadal and synoptic data produced as the satellite data archive accumulated.

Data outputs.

- A "Greenness" index on a dekadal basis, these can be PVI, NDVI, GEMI *etc.* depending on initial ground-truth calibration results.
- Surface temperatures estimates using split window techniques.
- METEOSAT estimated rainfalls.
- Land-use types, biomass estimates *etc.* can be derived from combinations of the above with the initial ground truth data. Predictions will become increasingly accurate as details of seasonality are incorporated in time and anomalies modified through user feedback.
- Combinations of the above with information on stocking density, habitation *etc.* in a GIS will allow areas of over and/or under exploitation to be highlight in real time.

197. See Figure A2.1 for a summary flow chart of these processing stages.

PERSONNEL REQUIREMENTS.

198. There should be an initial consultative phase where requirements are tailored for programme needs. Computing systems would be installed and configured with automation procedures for repetitive tasks. Products should then be generated "in house" and validated by extensive ground truth.

199. After installation and configuration the system could probably be run by one person, so long as a significant degree of automation is "built in" initially.

CONTINGENCY PROCEDURES AND ALTERNATIVE DATA SOURCES.

200. If country based systems were to fail it is possible to acquire NOAA/AVHRR data from commercial sources. The National Remote Sensing Centre (NRSC) in England can supply such data for Jordan for approximately US$3000/month, providing the scenes are ordered well in advance. It may be sensible to negotiate some contingency procedures with NRSC during Project start-up, to ensure a reliable data supply.

201. Furthermore, synoptic AVHRR data is readily available from historical archives through NOAA/NASA Pathfinder projects (James and Kalluri 1994). This data is at a lower 8 x 8 km resolution, but stored along with each image (as additional data layers) are ancillary information including cloud-cover estimates, satellite view angle and sun angle data (Agbu and James 1994). These data are made freely available to scientific institutions and can be ordered on a daily basis from 1981 to the present. They are is distributed on a variety of media including CD-ROM and DAT, as well as via the Internet.

202. Further satellite data is also available. The French System Pour L'Observation de la Terre (SPOT) satellites can provide further high resolution imagery (10 x 10m) if required, but suffer the long repeat times of all such high spatial resolution systems. Superseding and complimenting existing satellites are the next generation of NASA Earth Observing System (EOS) satellites constructed with the objective to produce a regular global dataset of well calibrated data of high radiometric resolution for a wide array of earth system sciences. They will have an onboard Moderate Resolution Imaging Spectroradiometer (MODIS) with 36 channels spanning the spectral range 0.415 - 14.235 μm, with spatial resolutions of between 250 m and 1 km, a repeat time of 16 days and the first is scheduled for launch in 1998. These are future alternative data sources and may been seen to augment the present programme when available. The METEOSAT, NOAA/AVHRR and Landsat satellite series are considered to the most cost effective solution of existing satellite systems.

Figure A2.1: The sequence of AVHRR Channel 1 and 2 data processing

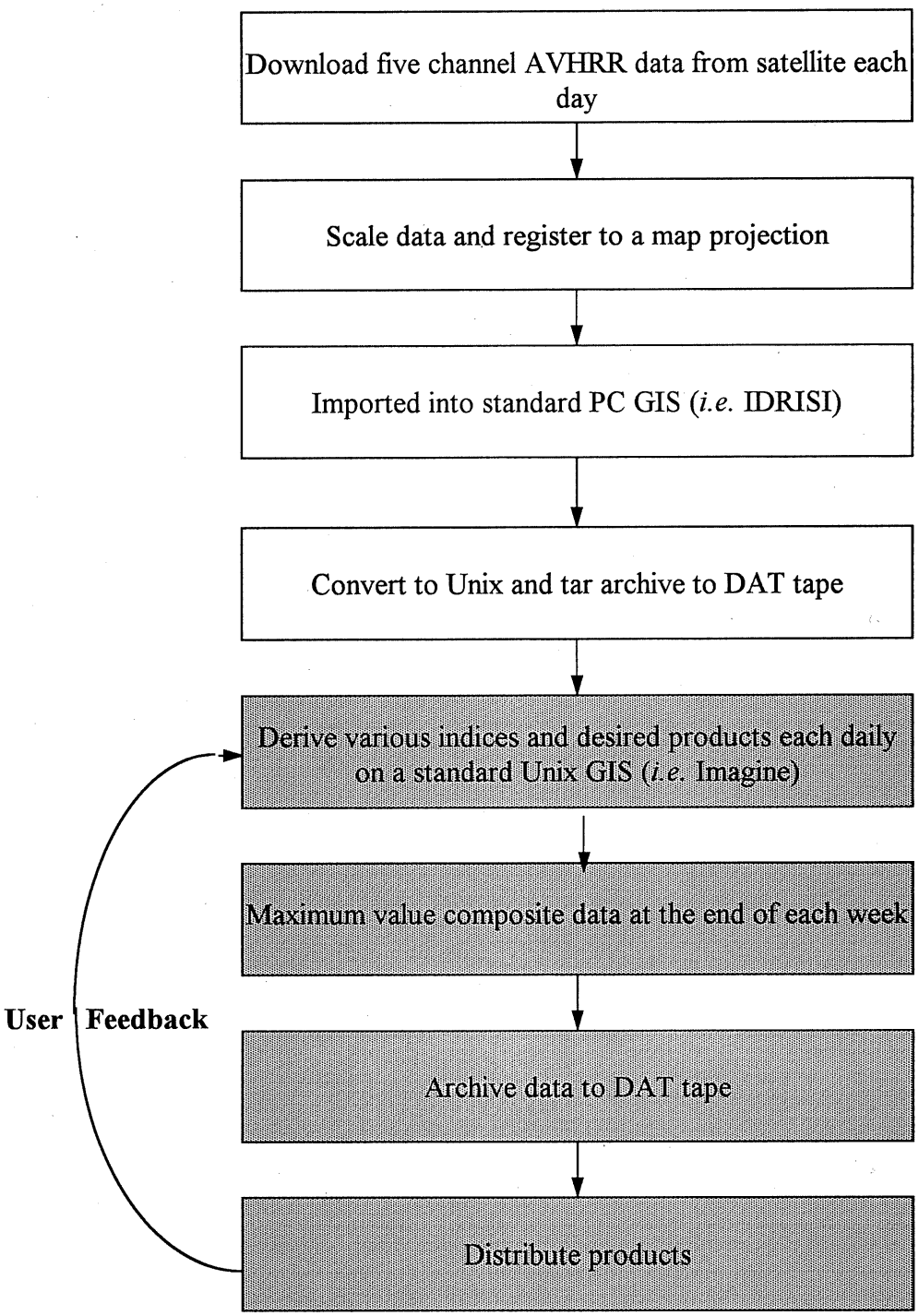
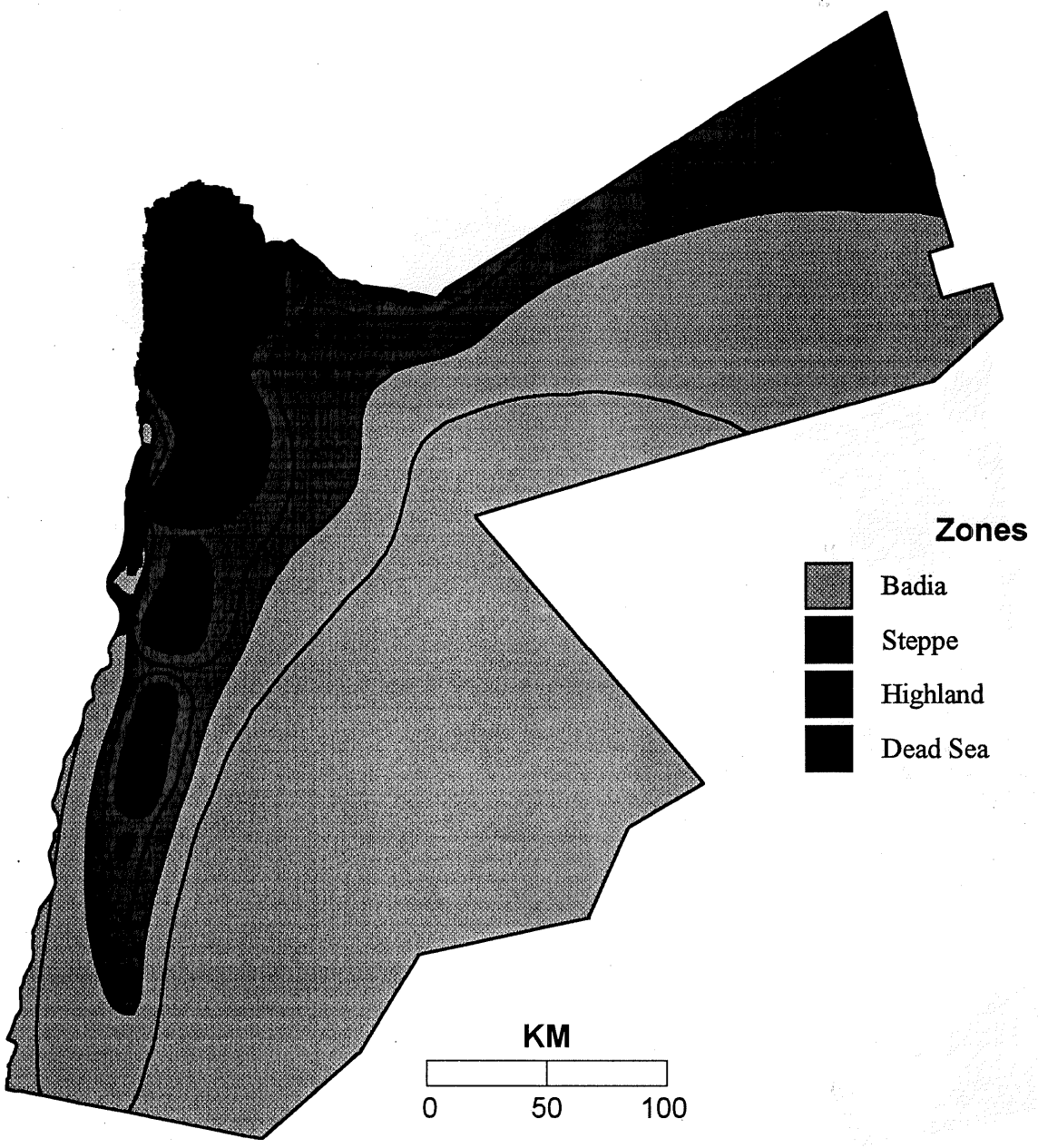
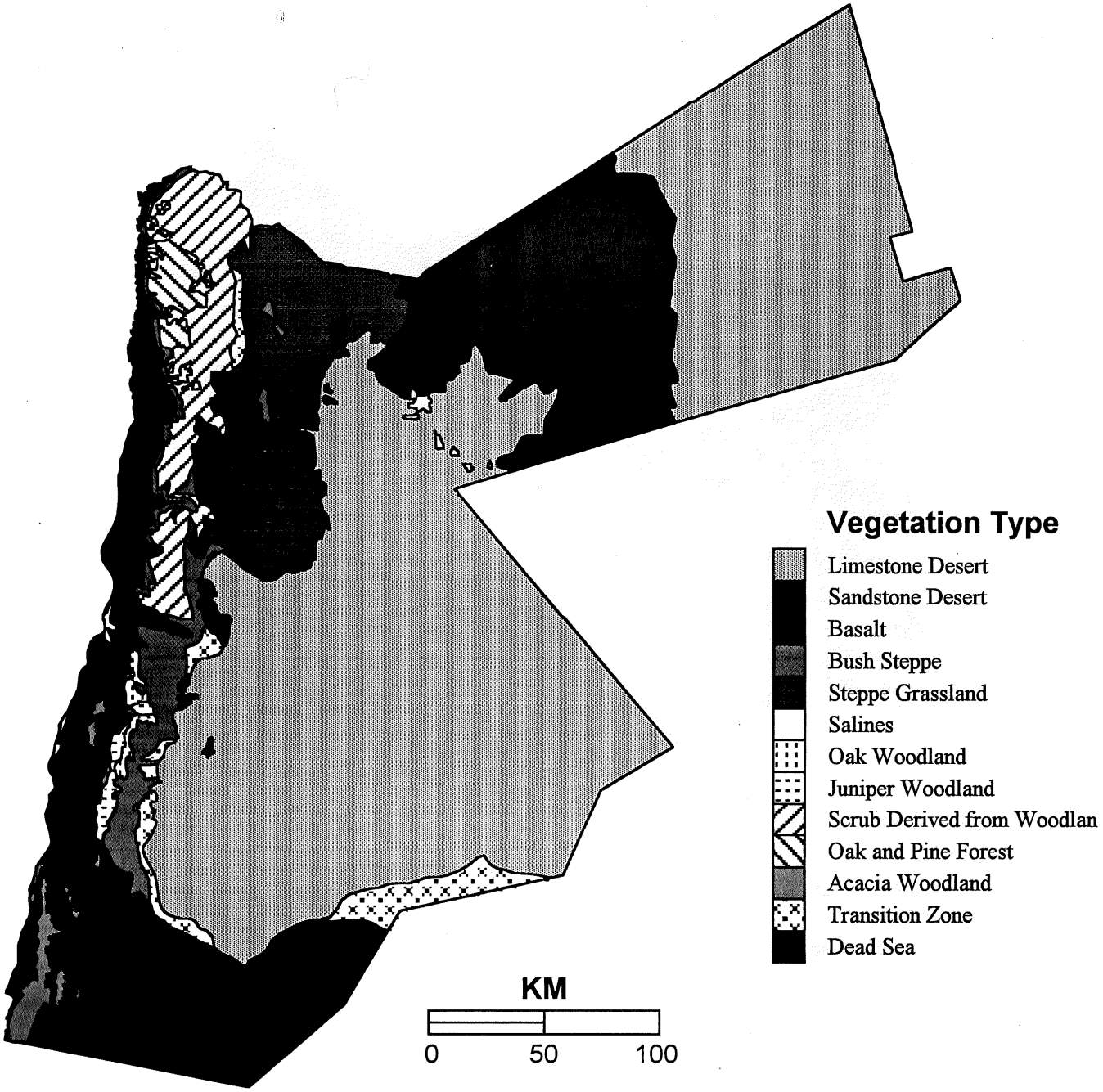


Figure A2.2: Agro-climatic Zones



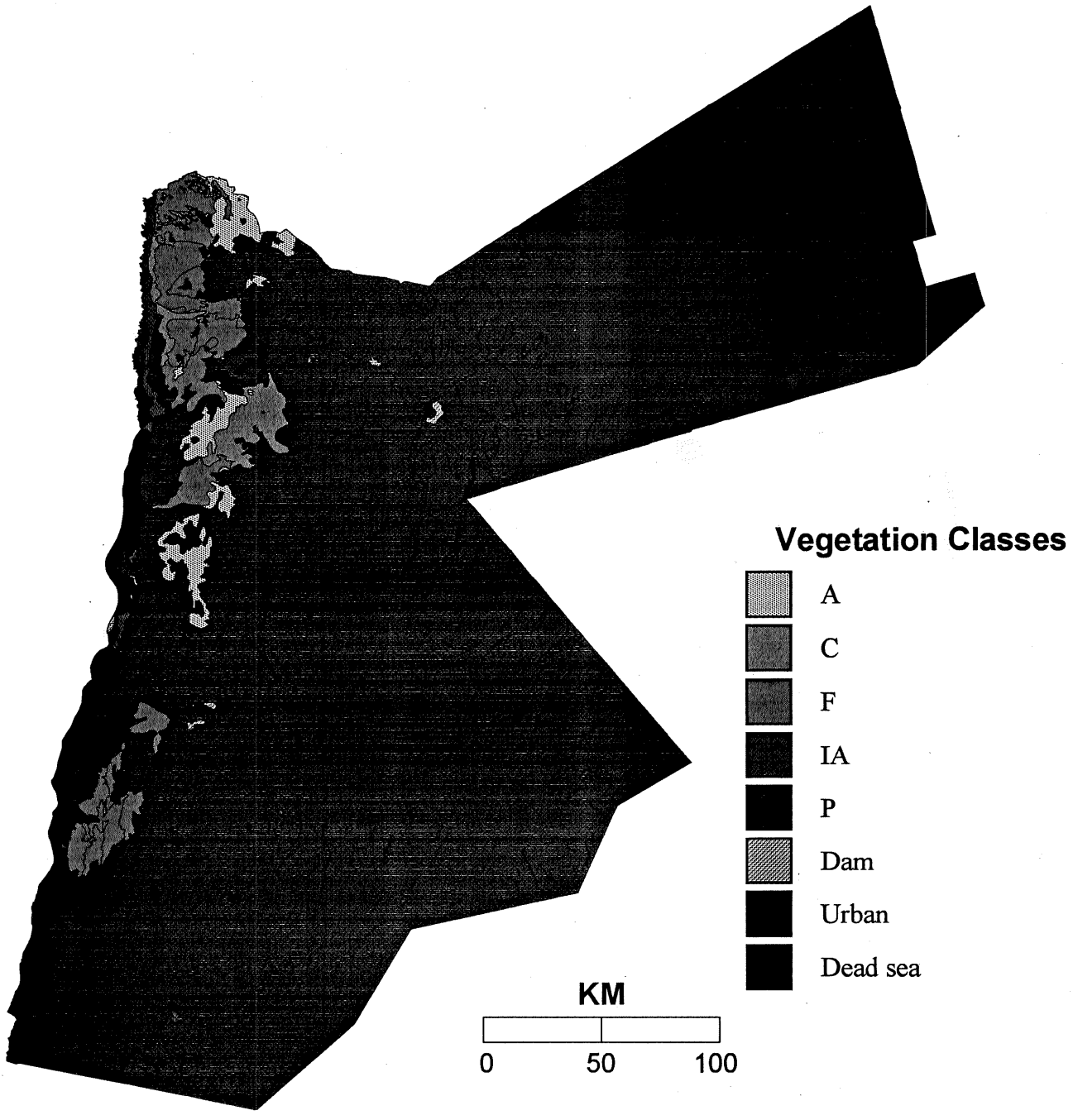
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A2.3: Huntings 1956 Vegetation Categories



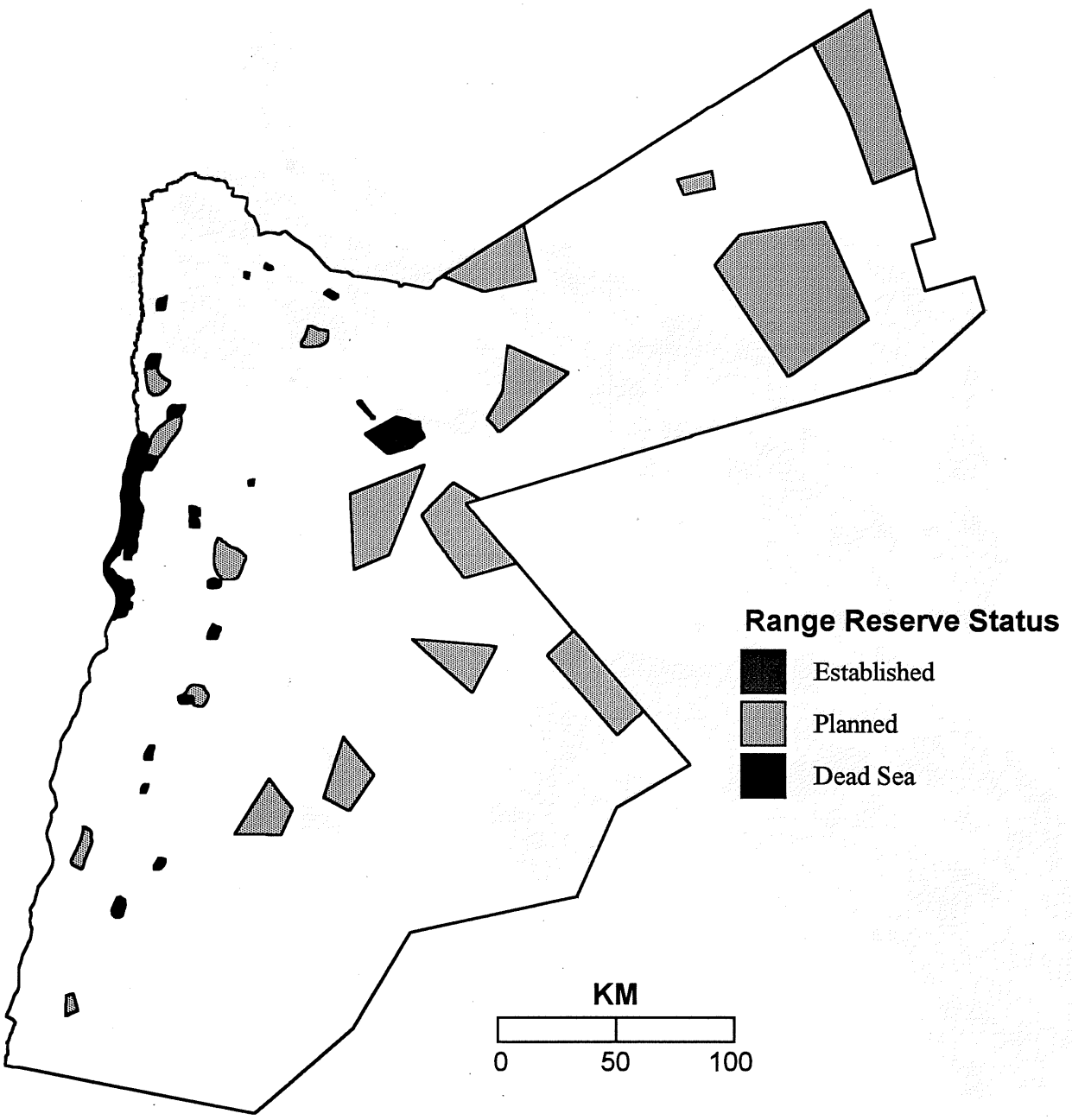
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A2.4: FAO (1991) Plant Associations



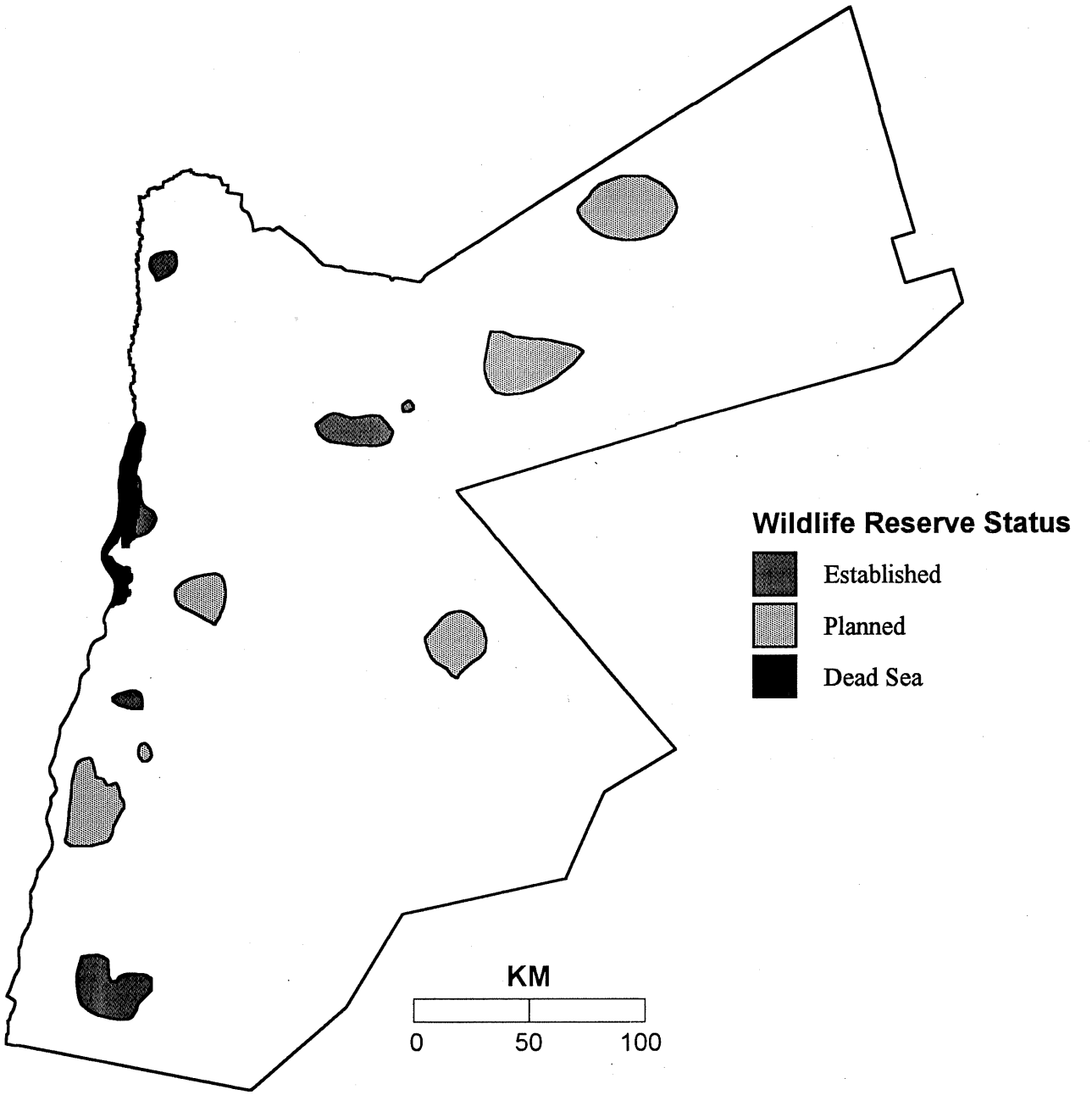
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A2.5: Rangeland Reserves



Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A2.6: Wildlife Reserves



Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

The Hashemite Kingdom of Jordan

National Programme for Range Rehabilitation And Development

Pastoral Resources Assessment, Monitoring and Co-ordinating Project

ANNEX 3: SOILS AND LAND USE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

1. Following preparation of the formulation report of the proposed National Programme for Range Rehabilitation and Development (IFAD, 1993), a Mission visited Jordan to prepare a Pastoral Resources Assessment and Monitoring Component. The Mission objectives were:

- to identify and evaluate information concerning pastoral rangeland and livestock related resources in Jordan, and to assess specific areas where relevant data are inadequate or unreliable; and
- to evaluate resource assessment and monitoring requirements, and identify priorities for institutional strengthening.

2. The main report of this Mission identifies a technical assistance Project which would be implemented by a Pastoral Resources Information and Monitoring and Evaluation Unit (PRIME), specifically established for the purpose.

3. This annex was prepared by the Soils and Land Use Specialist, who was required to:

- review information relating to current assessment and monitoring of cultivation and land use practices, land cover (and particularly extent of natural rangeland), soils, erosion and water resources;
- design, if appropriate, a protocol for land capability mapping for rangeland development;
- specify data, personnel and facilities required for filling gaps and updating the information; and
- design field studies and monitoring programmes in close collaboration with relevant Jordanian institutions.

AVAILABLE INFORMATION AND EXPERTISE

4. Information relating to soils, climate, hydrology, land cover and land use was examined to identify gaps in the information relating to Jordan's rangelands. Discussions were held with staff of the following institutions:

- Soils and Land Use Division (SLUD), Department of Forestry and Range (Ministry of Agriculture)
- Meteorological Department (Ministry of Transport)
- Department Water Resources Studies, Water Authority of Jordan (WAJ), Ministry of Water and Irrigation
- Royal Jordanian Geographic Centre (RJGC)
- University of Jordan, Department of Soil Science
- National Centre for Agricultural Research and Technology Transfer (NCARTT).

5. A field visit was also made to the Badia Project based at Safawi, which is co-ordinated by the Higher Council for Science and Technology.

6. The helpful co-operation given by the staff of all these institutions is gratefully acknowledged.

7. The most important sources of published data are listed in Table A3.1.

Table A3.1: Published Information about Soils and other Land Resources

Responsible Institution	Title	Volumes or Parts	Author	Date
Division of Soil Survey, Department Forestry and Range, Ministry of Agriculture	The Soils of Jordan, Level 1 Reconnaissance Soil Survey	Volume 2 Main Report, Volume 3 Representative Profiles & Soil Analyses	HTS Ltd. & Soil Survey & Land Research Center	1993
Division of Soil Survey, Department Forestry and Range, Ministry of Agriculture	The Soils of Jordan, Level 2 Semi-Detailed Studies	Volume 2 Main Report, Volume 3 Appendices	HTS Ltd. & Soil Survey & Land Research Center	1994
Division of Soil Survey, Department Forestry and Range, Ministry of Agriculture	The Soils of Jordan, Level 3 Semi-Detailed Studies	Volume 2 Main Report, Volume 3 Appendices	HTS Ltd. & Soil Survey & Land Research Center	in press
Division of Soil Survey, Department Forestry and Range, Ministry of Agriculture	Jordan Soil and Climatic Information System (JOSCIS)	User Guide and Reference Manual DBMS Volume & GIS Volume	Bechtold, G	1993
Muwaqar Project, University of Jordan	Annual Report 1987-88		A. Taimeh	1988
Water Authority of Jordan	Stream flow data for 1991/92		WAJ Information Section	1994
Water Authority of Jordan	Spring flow data for Sep 1990-Oct 91		WAJ Information Section	1994
Water Authority of Jordan	Water level data for monitoring wells 1991/92		WAJ Information Section	1994
Water Authority of Jordan	Groundwater quality data prior to 1985	Tech Pub No 53	Department Water Res.	1987
Water Authority of Jordan	Rainfall data in Jordan 1985-1990	Tech Pub	Department Water Res.	1992
Water Authority of Jordan	Rainfall intensity-duration-frequency in Jordan		Eng Ali Sa'ad	1986
Meteorological Department	Jordan Climatological Data Handbook		Meteorological Department	1988
Meteorological Department	Climatological Data of Jordan 1994		Meteorological Department	1995

SOILS INFORMATION AND EXPERTISE

8. Soils and land cover information at reconnaissance level is available for the whole country. More detailed information is available only in the higher rainfall areas, which are suitable for cropping. The Soil and Land Use Division (SLUD) in the Ministry of Agriculture has, as a result of its EU funded National Soil Map and Land Use Project, developed a capability to provide soils and land cover information from a comprehensive soils data base/GIS facility (JOSCIS), and has a team of pedologists trained in soil and land use mapping, analysis of satellite imagery and air photographs, and analysis of physical and chemical soil properties.

9. SLUD associates with RJGC for topographic mapping, aerial photography, satellite image processing, film writing and map production. Topographic maps are available at 1:250,000 scale and 1:50,000 scale. The 1:250,000 scale maps have been digitised and digitising of the 1:50,000 scale maps is in progress. Aerial photographs are available at 1:50,000 scale for all of Jordan with larger scale availability in some areas. The Department of Lands and Surveys maintains records of land registration and ownership which are available in summary form to government institutions. Detailed cadastral survey data are gathered but are for strictly limited distribution.

10. The National Soil Map and Land Use Project was established in 1990 with the assistance of Hunting Technical Services Ltd and The Soil Survey and Land Research Centre (Cranfield University). During this project the Jordan Soil and Climatic Information System (JOSCIS) was established, which combines GIS facilities with a comprehensive data base management system (DBMS) containing soils, climate and land cover information for Jordan. A staff consisting of three senior soils and land use specialists, nine junior soils and land use specialists and three computer/data base specialists are employed by the Ministry of Agriculture. The Soil and Land Use Project has now become a separate Division (SLUD) within the Department of Forestry and Range.

11. Reconnaissance soil maps were prepared during the Level 1 survey, which was carried out between 1990 and 1995, (HTS & SSLRC, 1993). This covered the whole at a mapping scale of 1:250,000 with field observations at an overall density of one site per 7.6 km^2 . LANDSAT multi-spectral imagery (April 1988/89), 1:60,000 and 1:100,000 scale aerial photography were used extensively during this work. Broad soil types were grouped into soil mapping units and depicted on 1:250,000 scale photo-maps produced from the LANDSAT imagery. The information has been digitised and is available as the map file 'soil2tot'.

12. Semi-detailed soil survey was carried out during Level 2 studies. These covered 9000 km^2 of land. Priority in the selection of these areas was accorded to land having potential for irrigated or rainfed crop production. The study areas are: NW Area, Central Plains, Central Highlands, Southern Highlands and Wadi Rajil, and are delineated on the map file 'levelii'(Figure A3.1). Panchromatic SPOT imagery, together with LANDSAT thematic mapper were used at 1:50,000 scale and combined with field survey at an overall density of 3.5 observations per km^2 to map these areas. Soil, land suitability and land cover maps were prepared at 1:50,000 scale.

13. Each area mapped at semi-detailed level extends into the steppe, which contains much of the best rangeland, and the Wadi Rajil area extends from steppe into desert regions. Large areas of the steppe are not included in this mapping.

14. Detailed soil survey was later carried out in smaller parts of the Level 2 study areas, on a 200m x 200m grid (i.e. 25 observations/km^2, and 1:10,000 scale maps were prepared using panchromatic aerial photography at 1:25,000 scale. This detailed scale of mapping is not required for rangeland areas.

15. During Level 1 studies the country was divided into 18 Land Regions, based on physiography. These are listed in Table A3.2 and delineated in the map file 'regxtot'(Figure A3.2). The most steeply sloping land regions are the escarpments on the rift valley rim and the dissected highland plateaux, the dissected basement complex in the SW and sandstone areas also in the South. Four major plains occur in the West of the country. Plateaux occur in the NE and E and the huge Jafr Basin occurs in the SE.

Table A3.2: Land Regions

	Name of Region
1	Jordan Valley
2	Wadi Arabah
3	Wadi Araba Escarpment
4	Jordan Valley Escarpment
5	Araba Hills Dissected Basement Plateau
6	Disi-Ram Highlands
7	South Jordan Dissected Sandstone Plateau
8	N Highland Dissected Limestone Plateau
9	Central Highland Dissected Limestone Plateau
10	S. Highland Dissected Limestone Plateau
11	Jordan Highlands Plateau
12	Jafr Basin
13	E Jordan Limestone Plateau
14	Hafira-Jinz Depressions
15	N Jordan Basalt Plateau
16	NE Jordan Basalt Plateau
17	NE Jordan Limestone Plateau
18	Aijun Highlands Dissected Limestone Plateau

16. Sample areas within each physiographic region were mapped at a semi-detailed level to examine geological, geomorphological and hydrological relationships affecting soils and land cover. This information is available in the soils data base for evaluation of rangeland resources. The sample areas are depicted in map file 'smpatot'(Figure A3.3).

17. Information on soil physical properties is available in the Level 3 Report (in press). This information is important as it determines soil water availability and runoff quantities which in turn influence the soil water balance. The information is only available in areas selected for semi-detailed and detailed soil survey, but many of the measurements were made in steppe areas and in Wadi Rajil. In all, tests were conducted on 53 Soil Series.

18. The soil physical tests were carried out on the major Soil Series in each US Department of Agriculture sub-group at representative pit sites that had been sampled for chemical analysis. Bulk density was generally low, ranging from 1.29-1.39 g/cm^3 for clayey and fine particle size classes, from 1.32-1.37 g/cm^3 for fine silty particle size classes, and from 1.23-

1.44 g/cm^3 for fine-loamy particle size classes. Average values were 1.34,1.35 and 1.39 g/cm^3, respectively.

19. The available water holding capacity was influenced by mineralogy, montmorillonitic soils having higher available water capacities than soils with mixed mineralogy. (Table A3.3).

Table A3.3: Available water holding capacity

Mineralogy	Particle Size Class	AWC (vol%)	Average
Montmorillonitic	Clayey/fine	14.8-17.4	16.5
	Fine-silty		17.4
	Fine-loamy		17.9
Mixed	Clayey/fine	14.8-17.7	15.8
	Fine-silty	15.6-16.5	16.1
	Fine-loamy	13.3-15.5	14.4
	Coarse-loamy		12.9

Source: Soil Map & Land Use Project

20. Average basic infiltration rates, measured by the double ring method, were found to differ according to soil moisture regime. In areas with a xeric soil moisture regime rates ranged from 3-99 mm/h. Measured rates were lower in the transitional zone (5-40mm/h), and lowest in the aridic soil moisture regime(1mm/h). In Wadi Rajil, rates ranged from 1-5mm/h. Low infiltration rates were found where ESP was above 4%.

LAND COVER INFORMATION

21. The 1987 1:25,000 scale topographic maps compiled from 1978-81 aerial photography show cultivated, orchard and forest areas and areas of grazing reserves.

22. During the National Soil Map Project it was not possible to map land use as information about specific cropping systems or rangeland management practices was not determined. However, land use descriptions and the floristic composition and ground cover at every soil observation point was described at each of the three survey levels, and this information has been recorded on the data base. Land cover was mapped in detail for all Level 2 study areas, and a detailed description of land cover classes mapped and statistics is presented in the Level 2 Report. Mapping was based on the topographic maps, 1:50,000 scale LANDSAT TM and SPOT panchromatic imagery (April 1992), using the very extensive field observations, and where necessary additional traverses for ground truthing. In the Salt Subheili area 1992 photography was also used.

23. The mapping units included rainfed cropping (high, medium, low and very low intensity) rainfed and irrigated orchard crops, irrigated field crops, brush range (more than and less than 30% cover), grazing reserves and several categories of unvegetated and sparsely vegetated land. Built up urban areas and other areas not available for agriculture have also been mapped ,which is important in a country where valuable land is being lost by further urbanisation.

24. Final mapping of land cover on the 1:50,000 imagery comprised simple units and complexes of either two or three units. Areas were calculated after digitising the maps.

25. Since the Project also had available 1988 LANDSAT MSS imagery in the form of 1:250,000, hard copy comparisons were made between 1988 and 1992. Differences were demonstrated in the extent of cropping influenced by rainfall, which was high in both years and temperature, which was higher in 1992 and resulted more advanced spring growth.

LAND SUITABILITY CLASSIFICATION

26. The Soil and Land Use Project introduced the FAO Land Evaluation Procedure, in which land suitability is determined for specified Land Use Utilisation types (LUTs). The land suitability classes defined for different purposes were highly, moderately, marginally suitable and not suitable (S1, S2, S3, and N, respectively).

27. Organisation of all the soils and related resources information in the DBMS and GIS facilitated land suitability mapping. Land suitability classes depend on soils, climate and other factors, which were incorporated in the GIS so that computer generated maps and tables showing areas of land with different suitability ratings for specified LUTs could be produced. During the project, land suitability was assessed for 5 precisely defined LUTs: rainfed annual cropping, rainfed perennial cropping, irrigated vegetables, rangeland, and forestry.

28. The rangeland LUT was defined as providing about 40 units per hectare (one unit being equivalent to 1 kg barley), where rainfall is less than 100 mm, rising to 100 units per hectare where rainfall is between 100-200 mm occurs. (Cropping of cereals and legumes is practised in the second category). In the highland areas there is a high proportion of planted species, and crop residues are important.

29. Land suitability criteria used for rangeland are presented in Table A3.4. Note that land in the larger part of the steppe, receiving on average 100-200 mm, is regarded only marginally suitable as range, and that if rainfall is less than 100 mm it is considered unsuitable. More detailed examination of runoff and run-on are clearly needed, before using the information provided to identify areas suitable for rangeland improvement.

Table A3.4: Land Suitability Criteria for Rangeland

Land characteristic	S1	S2	S3	N
mean annual rainfall	300	200-300	100-200	<100
winter growth potential	400	250	NL	
AWC mm	110	70-110	40-70	<40
pH	<8.6	<8.9	NL	
CEC	10	5-10	NL	
ECe	<2	2-8	8-30	>30
Erosion rill/gully		slight	moderate	severe
Sheet Erosion /wind		moderate	severe	
Slope(%)	<26	26-40	41-60	>60
Rock outcrop	<20	21-50	NL	
Surface stones	<30	31-60	NL	
Stones in horizon 1	<20	21-50	NL	
Inf rate terminal	>8	4-8	NL	
Inf rate initial	>35	20-35	NL	
ESP	<3.5	3.5-5	NL	

Source: National Soil Map and Land Use Project

30. Land suitability based on the criteria adopted for rainfed cropping and rangeland has been presented for each Level 2 study area.

31. In the Central Plains Study Area, 45% of the area should only be used for cropping if irrigation can be supplied, and a further 16% should only be used for rangeland or forestry.

32. In the Central Highlands, 15% of the area should only be used for cropping if irrigation can be supplied, and a further 45% should only be used for rangeland or forestry.

33. In the NW, 22% of the area should only be used for cropping if irrigation can be supplied and a further 30% should only be used for rangeland or forestry.

34. In Wadi Rajil, 30% of the area can only be used for cropping if irrigation can be supplied, 23% is assessed as marginally suitable as range, and 45% unsuitable even as range, having less than 100 mm rainfall in the average year.

VEGETATION MAPPING

35. Climate, topography and soils have an overriding influence on vegetation distribution in Jordan, resulting in four agro-ecological zones.

36. Woodlands occur in the Mediterranean region and trees are scattered in areas subject to grazing. *Poterium* scrub was found on shallower soils in this area, indicating land degradation leading to replacement by dwarf scrub.

37. Steppe vegetation occurs mainly in the rainfall range 100-250mm, but is also found in wadi channels receiving runoff. Between 250 and 350 mm steppe species occur in association with Mediterranean transitional species. Two major types occur, *Artemesia* brush steppe and grassland steppe. The brush steppe occurs south of El Qatrana, and on the escarpment and consists of *Artemesia, Retama and Salsola.* Grassland steppe, consisting mostly of grasses such as *Poa* and *Carex* species, occurs extensively in the North, with patchy steppe on parts of the NE limestone Plateau.

38. In the sandstone and granite desert regions, significant vegetation cover is confined to wadis, sand sheets and fans. This is an important source of grazing and browse. These areas are subject to increased moisture supply from runoff from higher areas or high infiltration, and ready availability of limited amounts of soil water.

39. In the limestone and basalt deserts, the major vegetation communities of value for grazing and browse are restricted to the numerous shallow wadi beds and depressions.

40. Valuable information on the state of rangelands and areas under cultivation soon after the introduction of the plough are available from the Rangeland Classification carried out in 1956. The basic data is available in the form of 1:25,000 scale aerial photography mosaics held by RJGC (or in some areas topographic maps) and original overlays held by SLUD. The mapping units used were vegetation communities (HTS, 1956), but were not based on climatic zones.

41. During the Soil Map and Land Use Project, a reclassification of the original Rangeland Classification mapping units, in terms of the four agro-climatic regions, was undertaken (HTS/SSLRC, 1991). This could provide a basis for mapping agroecological zones at

1:250,000 or 1:50,000 scale, and could also provide a basis for relating present vegetation to degradation states.

42. A 1:250,000 vegetation map has been prepared by an FAO project in the Forestry Division in 1991. This has been digitised by SLUD and is available as the map file 'veg2tot' (See Annex 2), and is based on plant associations originally described by Long (1957).

EROSION AND LAND DEGRADATION

43. Soil erosion is highlighted as one of the major factors in degradation of land resources in Jordan in the National Environment Strategy (IUCN, 1991). The main rainfed cropping areas, which are also important for grazing, are reported as being threatened by soil erosion and forest tree removal. Both steppe areas (land receiving 100-250 mm in an average year) and Desert areas (land receiving less than 100 mm in an average year) are reported to be subjected to erosion by water and wind, with sand dune formation and loss of rainwater, through evaporation additional related problems in the drier areas.

44. Taimeh (1991) lists the factors thought to contribute to erosion. In the rainfed cropping areas, overgrazing of post harvest plant residues is a possible contributing factor, which suggests that grazing on steep and otherwise highly erodible land should be regulated. In the drier areas, erosion is linked to loss of vegetative cover and intensive rainfall events. However, there has been very little quantitative measurement of erosion from either cropped land or rangeland in Jordan. During the Soil Map and Land Use Project, systematic assessments of visible effects of soil erosion were recorded in all parts of the country, and this information is stored in the DBMS. There is little evidence of large scale accelerated erosion.

45. The steppe lands were reported to be especially prone to erosion by wind and water, once the protection afforded by the vegetative layer is removed, because the soils have high contents of silt and silt sized $CaCO_3$ and are often weakly structured below the root mat. Continuous heavy grazing is a major factor leading to loss of the protective vegetation, currently estimated to have taken place in 30% of the steppe and more extensively in certain areas. It seems that in the desert areas, except in wadis and on some sand sheets, vegetation plays little role in soil stabilisation; a black gravel *hammada* provides effective protection of the soil surface, and this is disturbed only by mechanical means.

46. Erosion is potentially a more permanent indicator of land degradation than change in land cover and floristic composition and, therefore, estimates of current erosion rates and related indicators are useful for monitoring rangeland degradation and improvement. Behnke and Scoones (1993) discuss measures for assessing rangeland degradation noting that large fluctuations in species composition, biomass and cover are characteristic of arid and semi arid rangeland subjected to erratic rainfall and that vegetation in these areas has adapted to disturbance. Erosion affects productivity of rangelands directly by reducing soil fertility, water holding capacity and infiltration of rainfall. However, loss of production may be partly compensated for in areas receiving runoff and deposition.

CULTIVATION AND LAND USE

47. Land use is influenced by agroecological zone and irrigation water availability. Four broad land use types were recognised during Level 1 studies: Rainfed Cropland, Steppe, Desert and Jordan Valley.

48. The Rainfed Cropland has a xeric moisture regime[1] and rainfall generally exceeds 250mm per year, although significant production occurs where rainfall is between 200-250 mm on deeper soils in valley bottoms.

49. In the Steppe, the deeper soils in valley bottoms have traditionally been used for barley and occasionally wheat. Rainfall is rarely adequate to produce a reasonable crop (500-1000kg/ha). The Rangeland Survey (HTS, 1956) reports that marginal lands were rarely ploughed before the advent of the tractor, but expansion of tillage occurred in the early 1950's, and ploughing has led to loss of vegetative cover and erosion.

50. During the Soil Map and Land Use Project, areas mapped in 1956 were investigated to identify changes which have taken place since 1956 (HTS/SSLRC, 1991). It was reported that there has been extensive ploughing of land in the Steppe, extensive planting of orchard crops, including olives in the rainfed cropping zone; substantial reforestation, and an expansion of irrigated agriculture. In the Level 1 Report reference is also made to increased ploughing and occasional cropping of the Steppe, and an increased intensity of grazing in the Steppe, but quantitative information is sadly lacking.

51. In the Desert Zone, sometimes referred to as the Badia, wadis and valleys support a significant range of palatable species providing important grazing and browse in winter to early summer. In some wadis and depression margins, where barley can be grown, severe erosion of wadi silts may occur. Earth dams may be used to impound runoff for irrigation.

52. Although land use was not mapped during the National Soil Map and Land Use Project the descriptions of the land cover mapping units for each Study Area given in the Level 2 report (HTS/SSLRC, 1994) give a great deal of information about land use that would be useful to PRIME's proposed activities.

53. For example in the Central and Southern Highlands study mapped as low intensity rainfed cropping, which occur in the 200-250mm rainfall belt, are reported to have mostly only been cultivated since 1970. The JOSCIS database also contains an agricultural land use intensity map (Figure A3.4), derived from the 1991 FAO Plant Associations Map (Annex 2).

54. The major irrigated crops in the Jordan Valley are vegetables, citrus and bananas. Wheat is sometimes grown under supplemental irrigation. In Disi/Mudawara wheat, forage and potatoes are grown under centre pivot irrigation, using groundwater. In other areas in the North limited water availability has led to salinity problems, groundwater is also used in the steppe region often for fruit. Horse shoe shaped earth dams on the NE plateau and cisterns are the most usual water harvesting techniques used.

55. Somewhat anomalously, the Soil and Land Use Division has no authority within the Ministry for land use planning. The Ministry of Agriculture organised a seminar on agricultural policy in 1991. Taimeh (1991) estimated that in Jordan only 3% of the country is suitable for rainfed cropping, 3% for perennial cropping and 3% is irrigable. He outlined a number of areas of concern relating to land use, including: fragmentation of land holdings, loss of agricultural land, control of soil erosion, soil moisture conservation, and limiting the cultivation of steppe land.

[1] Soil is moist in part for more than half the time that the soil temperature at depth of 50 cm is higher than 8^0 C

56. The Muwaqar project was established by University of Jordan in 1985 to assess the possibilities for improving production in the steppe belt by harvesting runoff, reducing erosion and improving soil fertility. The EC assisted with funding from 1985-89. A soil survey of the 200 hectare field site, 40 km SE of Amman, was carried out, a meteorological station was established and dams were built to control runoff. Experimental work was delayed due to late delivery of equipment, but observations on the regenerative capacity of unvegetated areas showed that 3-4 years of protection encouraged good recovery without seeding.

57. This project has now been expanded, with additional technical assistance from the EU, to cover off site studies in the steppe to promote the uptake of findings amongst a wider group of potential beneficiaries. The new project, "Improvement of Agricultural Productivity in Arid and Semi-Arid Zones of Jordan", is a co-operative project between the University of Jordan and the Ministry of Agriculture, with technical assistance provided by Silsoe College. The SLUD will participate by providing expertise in soils and land use mapping.

58. The general approach of this project (Univ. Jordan, 1995) is to divide the 12,000 km^2 steppe area into catchments, which will be regarded as basic units for land use planning. The data base developed by SLUD will be used to provide soils, climate and land use information. Soil and water management practices involving water harvesting, supplemental irrigation, and rangeland improvement will be tested at a number of representative sites across the whole area. Options based on appropriate water and land allocations will be worked out on a catchment basis for presentation to farmers.

CLIMATIC INFORMATION

59. The Meteorological Department of the Ministry of Transport maintains 35 meteorological stations throughout Jordan. The Jordan Climatological Data Handbook (Meteorological Department, 1988) provides mean monthly data, calculated over 10-30 years for 32 meteorological stations, which includes:

- Air temperature
- Soil temperature
- Rainfall
- Relative humidity (06.00, 12.00 18.00 hrs)
- Wind speed and wind run (19 stations)
- Vapour pressure
- Sunshine (21 stations)
- Solar radiation (9 stations)
- Class A pan evaporation
- Potential evapo-transpiration (7 stations)

60. Every year the Meteorological Department publishes mean monthly data in e.g. Climatological Data of Jordan, (Meteorological Department, 1994). Elevation, latitude and longitude for all stations are provided in both publications.

61. There is a separate Agro-meteorological Division in the Department, staffed by an agro-meteorologist and two statisticians. Seven of the meteorological stations are maintained specifically to serve agricultural needs. The Division provides a ten day Agro-meteorological Bulletin, which provides 10 day means of agro-meteorological data, including soil temperatures to 100 cm depth, Class A pan and potential evapo-transpiration calculated by the 1977 FAO modified Penman Method (without correction factor). Calculations showed slight underestimates, when compared with lysimeter data measured in 1970-72. The agro-meteorologist uses a simple water budget to provide a 10 day calculated soil water balance. The Division has one 486 computer and INSTAT software for agro-meteorological calculations.

62. Additional rain gauges are maintained by the Ministry of Water and Irrigation. Data from these stations are phoned into the Meteorological Department on a daily basis. Since 1990 daily meteorological data have been entered on a CLICOM (WMO) database and data going back to 1988 is available in this format. Rain gauges are fitted with chart recorders. The information required for calculating rainfall intensity is therefore available for analysis.

63. Climatic information from the Meteorological Department and WAJ has already been used extensively by the Soils and Land Use Division. Rainfall and temperature regime data are incorporated in the soil and climatic data base (JOSCIS), from which a list of the latitude and longitudes of all stations is obtainable. Relatively few of these stations are in rangeland areas. A precipitation map derived from these data is shown in Figure A3.5.

64. A meeting was held with the Director General of the Meteorological Department, during which it was agreed the agro-meteorologist would provide meteorological data required by PRIME, the agro-meteorologist would also participate in data analysis specifically relating to water balance studies in the steppe and in lower rainfall areas. The agro-meteorological station at Wadi Dhuleil and six other meteorological stations in lower rainfall regions would provide appropriate information for rangeland areas. The agro-meteorologist is interested in expanding services to meet rangeland development needs, possibly using automatic weather stations and rain gauges fitted with single channel data loggers. He would install meteorological equipment, calculate rainfall erosivity and carry out statistical analysis of data to assess the influence of variation in climatic conditions that might mask long term land degradation.

HYDROLOGICAL INFORMATION

65. In Jordan, the Ministry of Water and Irrigation has responsibility for all surface and groundwater resources including water used for irrigation purposes. The Ministry has three Branches: (1) Jordan Valley Authority, which is responsible for irrigation and related services nation-wide; (2) Water Authority of Jordan; and (3) The Ministry of Water and Irrigation. The latter is responsible for Policy and Planning and is concerned with initiatives to establish water resources assessment and monitoring functions, inter-sectoral activities and helps to support a Water and Environment Research and Study Centre. A National Master Water Plan is currently being designed which may affect these institutional arrangements.

66. Substantial water resources databases exist for Jordan. These include rainfall, evaporation rates, base stream flow, flood flow, spring flow, ground water table levels, groundwater quality and groundwater abstraction. All this information is published at regular intervals (WAJ, 1987, 1992, 1994 a, b & c).

67. For water resources purposes the country has been divided into basins:

- Amman Zarqa
- Yarmouk
- Jordan River Valley Floor
- North Wadi Araba
- Azraq
- Jafr
- Sirhan
- North Rift Side Wadis
- Dead Sea
- South Wadi Araba
- Disi and South Desert
- Hammad

68. Comprehensive water resources investigations have been made for most areas and provide more locally specific information complementing the WAJ databases (WAJ 1989, 1989b; Ministry of Irrigation, 1989).

69. In some of these basins abstraction exceeds the safe yield, and dams have been constructed (in Amman Zarqa, Yarmouk, Jafer, Azraq, Dead Sea) for artificial recharge. In North and South Wadi Araba, the North Rift Side Wadis and in the Hammad and Sirhan Basins, abstraction does not exceed safe yield, whilst in the Disi and Southern Desert Basin groundwater is deep and not renewable.

70. Information on surface water resources, which are of specific interest in rangeland improvement is available for 15 surface management basins and 95 sub-basins. WAJ monitors base flow and flood flow measurements from springs, streams and reservoirs and monitors groundwater levels and water quality.

71. WAJ is responsible for 292 rainfall measurement stations, but 95 are not working. WAJ is responsible for 32 evaporation stations, but 11 are not working. The co-ordinates and operational status of these stations are available in the JOSCIS data base..

72. WAJ Rainfall stations are present in all regions and this network complements that provided by the Meteorological Department. Despite the extent of the monitoring network, information for specific locations is generally very limited and few flow monitoring points are provided in the rangeland areas. One of the hydrologists in this Division would be able to provide hydrological and groundwater data, and assist in monitoring stream flow and runoff for water balance studies.

73. The USAID funded 'Water Quality Improvement and Conservation Project' is currently being implemented by the Ministry of Water and Irrigation assisted by a team of consultants appointed by Development Alternatives Inc. Components of this project include improving the water resources data management system, the water resources and water quality monitoring system, the water quality testing service, pilot studies concerning artificial groundwater recharge, improving irrigation water use efficiency and delivery. The project will also work with the Jordan Environment Society to promote water conservation awareness.

74. Of importance to PRIME are plans to improve the monitoring network and data base and studies concerned with groundwater recharge. A site where recharge is being monitored would be a useful location for water balance studies.

INFORMATION FROM REMOTE SENSING

75. Remote sensing facilities are important in soils and land use mapping. Both aerial photography and satellite imagery were used extensively during the National Soil Map and Land Use Project. Although image processing was previously undertaken outside the country, SLUD now has image processing facilities and access to imagery in computer compatible form. Pedologists in SLUD have considerable experience of image interpretation and use of imagery in mapping soils and land use.

76. In addition, the RJGC has sophisticated image processing capabilities and a wide range of expertise in the development of remote sensing applications. The Centre also has overall national responsibility for land and aerial survey, and the production of maps, and is working with the NIC of the Higher Council of Science and Technology to integrate geographic data collection in the NIS.

77. Consultations were held with RJGC to plan how the combined expertise of RJGC and SLUD could be brought together to support PRIME. The remote sensing section in RJGC is at

present sharing hardware facilities with the GIS section (2 VAX computers and an HP workstation running several PC's), but a second workstation is being purchased. Image processing software is being upgraded with the introduction of PCI software which is compatible with the SPANS GIS used by SLUD. RJGC currently uses AERIES3 and VIPS32 image processing systems.

78. Six remote sensing specialists work in RJGC, and between them have specialist knowledge of surveying, geology and hydro-geology, hydrology, geomorphology and agricultural applications.

79. Several of the studies recently conducted by RJGC have involved soils, land use and water resources applications including:

- Mapping of surface water bodies, catchments and vegetation cover in ESCWA region countries;
- Mapping of potential dam sites in Western and Central Jordan;
- Surface water management in Wadi Wala Basin;
- Use of SPOT imagery for mapping floods;
- Crop suitability mapping in Irbid area;
- Desertification study in Mafraq.

80. RJGC is equipped with a film writer, electrostatic plotter, 2 ink jet printers, 1 scanner, 4 digitising tablets and field survey equipment.

INTEGRATION OF SOILS AND LAND USE INFORMATION IN GEOGRAPHICAL INFORMATION SYSTEMS

81. During the EU funded National Soil Map and Land Use Project the Jordan Soil and Climatic Information System (JOSCIS) was established and is described by Bechtold 1993. This data base (DBMS) is the main repository for information about soils and land cover of Jordan, and is national in extent. Climatic data and hydrological data are combined in the data base to provide a very comprehensive information system, with all information required for assessing land suitability for different purposes. Information on soil erosion, land degradation, land use and much more can be provided for monitoring studies and research purposes.

82. The Ministry of Agriculture intend to maintain this facility, which is now established in the Soils and Land Use Division (SLUD) within the Department of Forestry and Range.

83. The DBMS is part of a GIS facility based on SPANS, and the Division is now contributing to the NIS and, at an international level, to the Global Soils and Terrain Digital Database (SOTER, which use ArcInfo. Both SPANS and ArcInfo can be used to combine soils, land cover, climatic and water resources data.

84. JOSCIS is run on several PC computers with a digitiser, plotter, and disk and magnetic tape drives. The DBMS consists of modules for data input and verification, data storage and database management, data output and visualisation, data transformation and user interaction. The main data source is the georeferenced point data obtained during field surveys and manipulated using DBase programmes written using CLIPPER.

85. SPANS GIS was adopted for the project because of the need for rapid spatial analysis of data representing soil units, achieved by use of the quadtree data structure. Both maps and

point data are imported, processed and exported from SPANS, either as SPANS MAP, or Autocad DXF and Paintbrush PCX, files. SLUD's capability to manipulate these data without external assistance appears, however, to be rather limited.

86. A selection of the maps available in digital form from the GIS that are particularly important for rangeland evaluation and monitoring are listed in Table A3.5.

Table A3.5: Selected Maps in Soil & Land Use Division GIS (JOSCIS)

Map	Source	Filename
Jordan International Boundary	RJGC	outxtot
Altitude, contour interval 100m	RJGC	altxtot
Soil moisture regime		aridtotap
Catchments	Water Authority National Water Master Plan	cat2tot
Dewfall mm/a	Dryland farming project	dewmtot
Ground frost days/a	Dryland farming project	fst1tot
Geology	Natural Resources Agency	gel1tot5
Governorates (1994)	RJGC	gov3tot
LANDSAT MSS image frames corrected to Jordan Transverse Mercator	EOSAT	imagtot
LANDSAT MSS images (3 bands)	EOSAT	mssntot (n=1 to 3)
Precipitation	National Water Master Plan	prc1tot
Rain gauges	WAJ	
Land regions		regxtot
Land systems (393 physiographic units)		
Rangeland survey areas	Ministry of Agriculture	rrlstot
Planned and established reserves	Ministry of Agriculture	rrlstot5
Groundwater salinity	National Water Master Plan	
Soil map Level 1, 161 soil mapping units in 10 sheets at 1:25,000 scale		soil2tot
Level 1 sample areas		smpatot
Level 2 study areas		levelii
Annual soil temp classes		temds
Vegetation, 13 units at 1:2,200000 scale	HTS, 1960's	vegxtot
Vegetation, 124 veg units in 13 sheets, at 1:250,000 scale	FAO Project in Forestry Div, Min. of Agriculture (1991)	veg2tot
1:250,000 scale vegetation and land use map	FAO Project in Forestry Div, Min. of Agriculture (1991)	veg2tota
Drainage basins	WAJ	draitot
Catchments	WAJ	cat2tot
Wildlife reserves	Ministry of Agriculture	wldrtot
Rangeland reserves	Ministry of Agriculture	rrlstot
Villages	RJGC	villtot

RECOMMENDED SOILS AND LAND USE STUDIES

87. There is at present insufficient information concerning the relationships between soils, climate, topography and productivity in rangeland areas to rate land in terms of rangeland productivity, potential for improvement, or risk of land degradation and soil erosion.

88. The Pastoral Resources Information Monitoring and Evaluation Unit (PRIME) would require a more detailed resources assessment than is possible from existing information, if it is to monitor changes that occur over the length of the project.

89. PRIME would also require a better understanding of these relationships, in order to identify possible means of improving rangeland, through restricting cultivation or grazing, conserving water, and reducing soil erosion.

90. Soils and land use monitoring activities would be needed to complement regular rangeland and livestock monitoring that would be carried out every year.

91. Since previous soil surveys and land use studies have been based on cropland, there is insufficient soils and land use information in steppe and desert areas.

92. Through the PRIME unit technical assistance in soils and land use survey and soil water balance/soil erosion investigation would be provided. Visits by a specialist in soil data base management would also be made. Training in skills needed for soil and land use evaluation, soil physics, remote sensing, data base management and GIS would be provided through technical assistance and short courses and Jordanian pedologists would be encouraged to participate in applied research activity relating to rangeland improvement. Facilities in Jordanian institutions would be strengthened to enable them to participate effectively in these special studies:

A). STRENGTHENING OF THE MINISTRY OF AGRICULTURE'S SOILS AND LAND USE DIVISION (SLUD)

93. Potentially, SLUD has an important contribution to make in Range Rehabilitation and Development throughout Jordan. Some weaknesses in the Division were identified during the Mission and these would be specifically addressed by the Project.

Objectives

- To upgrade the capability of SLUD to provide information relating to rangelands from the computerised data base;
- To promote SLUD and help ensure facilities are maintained over the longer term; and
- To foster international collaboration in soils and land use evaluation and monitoring, using GIS and soil water models

Methods

94. The Soil Information System is running under SPANS 5.2 and Dbase4. A review of computer operating systems, the data base management system and GIS in use by the Division would be required. It would be important to PRIME that a computer is available for its use in SLUD, with full upgrade and maintenance support for SPANS Version 6 when available, as well as the SPANS Windows compatible Explorer software. A computer and all necessary software would be provided and installed.

95. Field recording systems would be reviewed, with use of field computers linked to GPS considered. Software for making field notes would be introduced.

96. Strict guidelines must be imposed on the use of information from the data base. Basic information about soil and soil properties can only be interpreted by experienced soil scientists. In return for maintaining ownership of the base data, the Ministry is responsible for making a wide range of interpretations for users, and for publishing information in report or map form.

97. The data base provides a means of developing revenue earning capability. Possibilities for this and cost recovery for services provided would be explored fully.

98. During the National Map Project eight field vehicles and one car were required. Needs for the current Project are not so great, but the three vehicles currently retained from the earlier project will have to be replaced in the near future.

99. During the National Map Project the laboratory facilities at Jordan Valley Authority were used, and these facilities were considerably strengthened. Consideration should now be given to development of a basic capability for soil chemical and physical analysis at NCARTT, which has closer institutional and professional links with SLUD.

100. The capacity for SLUD to monitor soil physical conditions and soil moisture affecting rangeland rehabilitation would require facilities for soil moisture measurement and monitoring, using tensiometers, sediment sampling and a tension infiltrometer.

101. Links with the Soil Survey and Land Research Centre (Cranfield) and the Soil Science Departments of a number of universities would be maintained to develop soil physics, GIS, remote sensing and modelling capabilities, and to support and encourage research in soil physics and land degradation.

Training Elements

102. A second pedologist would be trained, partly overseas, to work specifically with the data base/GIS specialists. A soil information specialist would be provided to organise this training. Either a soil scientist recently completing MSc studies at the University of Jordan, or one of the pedologists with field experience could receive this training. In addition, all pedologists would receive some training in data base/GIS work.

103. The computer programmer would be trained in specific software programmes. (Training for the GIS technician is covered under: B.) Land Suitability Mapping, below)

Timing and Cost

104. Facilities would be improved on start-up of the project. Technical assistance would be spread over four years and maintenance extended over the whole 5 year Project. Training should be carried out during the first two years. The total cost is anticipated at US$130,474, detailed in Annex 5.

Table A3.6: Schedule for Strengthening Soils & Land Use Division

	PY1	PY2	PY3	PY4	PY5
Computer Programming	3 months				
Technical Assistance Soil Information Specialist	1 month	1 month	1 month	1 month	
Training Pedologist Research Grant	1yr	9 months			
Equipment Computer SPANS upgrade Maintenance. contract on SPANS	1yr 1yr 1yr	1yr	1yr	1yr	1yr

PY = Project year

B). LAND SUITABILITY MAPPING

105. The rangelands of Jordan are under pressure. They are heavily used by grazing livestock and are in some areas used for cultivation and in demand for urban use. This means that policy makers need to make decisions concerning the most appropriate use for land.

106. The forage production capability of rangeland is limited by soil and climatic factors and may be altered by human interventions. Productivity may be increased through controlled grazing, or by conserving water or reducing soil erosion. Productivity can also be decreased by cultivation and overgrazing, but it is not known whether the rangelands are permanently damaged by such practices. Both pastoralists and policy makers need to know which land is most suitable for supporting livestock and what alternative development options their might be.

107. Land suitability classification provides a simple ranking of land in terms of relative repayment capacity when used for a specified purpose, in this case for providing feed to grazing animals. It is based on information about soil or land characteristics and climate, and how these affect forage production. This information is obtained from soil survey and analysis of climate data. The accuracy of the classification depends on the detail of the information available. When combined with the relevant vegetation and socio-economic data, such classification provides the information required to assess rangeland potential.

108. For the National Soil Map and Land Use Project, land suitability assessments were made for a number of alternative land utilisation types including rangeland suitability. The criteria used for this would be modified to make maximum use of all the available soils and agroecological information in the assessment of rangeland potential and prediction of response to specific rangeland improvement measures.

Objectives

109. To prepare land suitability maps, focusing on rangeland areas and elucidate on their development potential.

Materials and Methods

110. The land suitability criteria for rangeland and for rainfed cropping would be revised to incorporate differences in soil moisture regime, as influenced by runoff and infiltration rates.

Information provided by vegetation may also be incorporated. Using information available in the soil data base for Level 2 study areas and outside Level 2 study areas for the sample areas shown in map file 'smpatot', a provisional new land suitability classifications would be made for all areas mapped at 1:50,000 scale. Range and land use specialists and economists would discuss the appropriateness of the suitability classification for making decisions about land use, and revisions would be incorporated as appropriate.

111. Since large areas of Jordan have only been mapped at reconnaissance level, areas having priority for more detailed rangeland suitability assessment would be selected for semi-detailed soil survey. An estimated 2,000 km^2 of land shown by reconnaissance soil survey to be suitable for improvement, or identified as being threatened by increased cultivation or urban expansion, would be selected for survey in the second and third year of the Project.

112. Soil survey would be carried out using internationally accepted methods for semi-detailed soil survey, in which observation sites would be selected to characterise mapping units that can be delineated using aerial photography or satellite imagery. Observation sites are selected to characterise landscape units. The exact location of the sites is chosen by the pedologist in the field, often by making traverses that are arranged to cross different landscape features. Where soil mapping units are complex, the density of observation may be more, and in areas that have uniform shallow soils the density be less, than the overall density.

113. The methods used for soil field description will strictly follow the standard methods for soil description used in Jordan, which are based on those of the US Department of Agriculture. In the areas selected the soil profile would be examined by augering, or by shallow pit excavation to 100cm depth, or to rock at 3-5 sites per km^2. Ten per cent of the observations would be fully described profiles.

114. Soil chemical and physical analysis would be carried out to determine soil fertility and water holding capacity and to help in the assessment of erosion risk. Laboratory methods will follow the standard methods of analysis used in Jordan, which are based on current internationally accepted procedures for soil survey work.

115. From previous experience, a combination of LANDSAT thematic mapper and SPOT panchromatic imagery was found to be the best combination of imagery for delineation of soil mapping units and would, therefore, be obtained, georeferenced and enhanced for the new study areas. It is anticipated that two frames would be required to complete coverage of all land receiving more than 100mm rainfall.

116. All information will be entered on the JOSCIS, and maps will be digitised and incorporated in the SPANS GIS.

117. This work would be carried out by pedologists from SLUD, working closely with the PRIME unit. The amount of image processing required would be small, and the remote sensing Department at RJGC is being equipped to do this using PCI. The study would expand on work being carried out by the EU funded University Project and to Badia Project (HCST), which do not have staff with experience of soil survey and land classification.

118. In areas not covered by the new study areas, reconnaissance level land suitability classification will be carried out based on existing soils information and extrapolation from sample areas.

119. If soil maps and land classification maps produced by this study are to be published, RJGC is the responsible authority for map publication and additional funding would have to be arranged.

Training Elements

120. The pedologists in SLUD are well trained in soil survey work, but have had limited opportunity to develop land classification procedures. Three months of technical assistance would impart important information to a receptive group of scientists.

121. A new method for rapid measurement of soil hydraulic properties, using a tension infiltrometer, would be developed and used to introduce the pedologists to field measurements of physical properties and data capture using data loggers.

122. Land suitability classification for new land use types is largely a computer operation, once soil mapping units have been defined and digitised. Training of a GIS technician to give him more experience of spatial analysis capabilities of SPANS is therefore included.

123. Pedologists are ultimately responsible for land suitability classification, and provision is given for one pedologist to study quantitative land classification procedures at an overseas research institute.

Timing and Cost

124. Information is available already for the initial assessment, which would start during the first year of the Project. This would immediately be followed by study area selection and acquisition and processing of imagery.

Table A3.7: Schedule for Land Suitability Classification

	PY1	PY2	PY3	PY4
Suitability Classification, and Area Selection	4 months (SLUD)			
Image Processing	1 week (RJGC)			
Soil Mapping, Land Evaluation and Soil Analysis	16 months (SLUD)	10 months (SLUD)	10 months (SLUD)	
Technical Assistance: **Soil/Land Use Specialist**	3			
Training: **GIS technician** **Pedologist**		3 months 9 months		
Field Equipment	x			
Map Production				x

125. Fieldwork for 2,000 km^2 would take an estimated 36 man months. SLUD pedologists would be able to complete soil mapping and land classification over a three year period. Since all information required by PRIME will be available in the GIS, map production can delayed while additional funding is found.

126. The total cost of the proposed study would be US$238,159, as detailed in Annex 5.

C). MONITORING SOIL WATER BALANCE AND SOIL EROSION EFFECTS

127. Two major indicators of permanent degradation of rangeland are net reduction in rainfall quantities retained in the soil for plant growth and net loss of fertile topsoil by erosion. Erosion by both wind and runoff are important in the drier parts of the region, particularly where infiltration rates are low.

128. A proportion of the rainfall actually falling on rangeland is lost by evaporation from standing water in enclosed drainage basins. Water harvesting practices including small dam construction or diversion structures would reduce these losses and the savings would need to be monitored.

129. Once soils have been mapped and the inherent soil properties influencing rangeland productivity have been determined, attention will focus on the water balance. Water balance studies are required to analyse and extrapolate the effects of improvement measures, and determine their sustainability and influence on moisture retention for plant growth, erosion sedimentation and groundwater recharge.

130. Contour furrows can reduce runoff and soil erosion but baseline estimates of present losses and gains of both water and soil would need to monitored in sample areas, to monitor their effectiveness.

Objectives

131. The objectives of this study would be to provide detailed information concerning the water balance and erosion in sample areas in the steppe and desert areas to help identify improved management practices and their effectiveness in overcoming constraints limiting productivity.

Materials and Methods

132. Water balance and soil erosion are influenced by soil physical properties, rainfall intensity and size of catchment. Collaboration between SLUD, the agro-meteorologist and a hydrologist from WAJ would be required to help quantify rainfall intensity, soil water holding capacity, soil erodibility, evaporation, runoff, recharge and water used productively by rangeland vegetation. The water balance would be determined at a series of point locations, and aggregated using spatial analysis capabilities of the SPANS GIS.

133. At least three sample catchments will be identified and slopes will be measured in detail.

134. Rainfall, soil water content and runoff will be measured. Water content will be measured by weighing, except during wet periods when tensiometers will be used.

135. Infiltration and soil hydraulic conductivity will be measured at several sites in each catchment using a tension infiltrometer.

136. Potential evapo-transpiration will be calculated and ways of estimating actual transpiration will be investigated.

137. Crop cover will be estimated for the sample catchments.

138. Rainfall erosivity will be estimated from rainfall intensity-duration estimates at all rain gauge stations located in the steppe and desert areas.

139. An automatic weather station and two rain gauges will be installed.

140. The data sets obtained from the investigation work will be applied to validate alternative models of soil erosion and soil water use by rangeland vegetation, and also used in hydrological models used by the Water Authority of Jordan to estimate recharge.

141. This work will be carried out jointly by an agro-meteorologist (Meteorological Department,) a hydrologist (Water Resources Department, WAJ) and a pedologist from SLUD, assisted by a soil and water management specialist provided under technical assistance during the first two years of the study.

Training Elements

142. Since there is no special expertise in soil physics available in Jordan, a soil scientist will be selected for 3 months special training in a suitable research institute or university in Europe.

Timing and Cost

143. This study will be started during the second year of the Project, with technical assistance spread over two years. The total cost is estimated to be US$130,859 as detailed in Annex 5.

Table A3.8: Schedule for Water Balance and Erosion Studies

	PY1	PY2	PY3	PY4	PY5
Soil Monitoring, Agro-meteorology and Hydrology		10 months	10 months	5 months	5 months
Technical Assistance Soil & Water Specialist		3 months	3 months		
Training Pedologist			3 months		
Field Equipment		x			

D). INTERACTION OF CROPLAND AND RANGELAND

149. It is expected that cultivation contributes to the degradation of rangeland, but no quantitative information is available concerning the extent of cultivation in rangeland areas, and it is not known if the effect of cultivation on rangeland productivity is permanent. To justify policies concerning limiting cultivation in areas receiving less than 200 mm of rainfall on average, more information on the influence of cultivation on rangeland productivity and on any permanent degradation of rangeland would be required.

150. There is information from a variety of data sources held by SLUD on historical trends in cultivation practices. These include records of field observations made in 1956, aerial

photography and satellite imagery, as well as comprehensive vegetation, land use and climatic data available in JOSCIS.

Objectives

151. The main objective of this investigation is to provide PRIME with a sound basis for defining agroecological zones and provide supporting land use data for the analysis of past trends in cultivation practices.

152. Cropping may also affect soil fertility, so more information about soil fertility of rangeland and cropped areas will also be obtained to determine its importance.

153. Water harvesting practices and irrigation possibilities alter land suitability. Ways in which these possibilities are taken into account in planning land use must be determined.

Methods

154. All the information available from aerial photography, LANDSAT MSS imagery LANDSAT TM and SPOT panchromatic imagery, overlays containing land use information drawn for the 1956 Rangeland Classification and from JOSCIS, would be used to obtain quantitative estimates of the extent of cultivation in different years for sample areas covering all land regions.

155. Current definition of agro-climatic zones for Jordan would be examined in relation to land cover which may provide better information for defining these than rainfall alone.

156. From past surveys, and during soil survey work in new study areas, soil pH, soil organic matter and available phosphorus would be determined.

157. The effectiveness of rainwater harvesting and irrigation on improving cropping potential would be investigated by monitoring soil water content, runoff and erosion. This work would be carried out in conjunction with research work carried out by the University of Jordan, in sample areas where average rainfall is in the range 100-250 mm.

158. This work would be done by SLUD pedologists, under the supervision of a senior pedologist who would be attached to PRIME.

Timing and Cost

159. The work would be carried out from PY2 onwards, so that continuity would be maintained in the collaboration between SLUD and PRIME. The total cost would be US$19,348, as detailed in Annex 5.

Table A3.9: Schedule for Land Use and Monitoring Studies

	PY1	PY2	PY3	PY4	PY5
Land Use		2 months	2 months	2 months	
Attachment to PRIME		1 month	1 month	1 month	1 month

TERMS OF REFERENCE FOR SOILS AND LAND USE STUDIES

163. Adequate information about soils, land use and related resources is available in Jordan, but much of it has not been collected or analysed with either rangeland rehabilitation and development in mind. Establishment of an integrated approach to range resource assessment, planning and management, is a prerequisite for sustainable development, and is the *raison d'être* for the Project.

164. Previous sections of this Annex have identified the need for further strengthening of SLUD, and have recommended a series supplementary studies, focusing on rangelands to complement existing soils and land use information, which is primarily concerned with arable land in higher rainfall zones. Three primary areas of investigation have been identified:

- Land Suitability Mapping
- Soil Water Balance and Erosion
- Land Use and Vegetation Change

165. Overall responsibility for commissioning and supervising these studies would be the responsibility of PRIME and, in particular, the Environmental Specialist, who would negotiate appropriate contractual arrangements with collaborating organisation and endeavour to ensure that studies were efficiently executed, kept to their allotted schedules and made available information, as and when required. (See Annex 1).

166. Additional short term technical assistance requirements and draft terms of reference for specialised inputs are outlined below.

TECHNICAL ASSISTANCE

Soils Data Base and GIS Specialist for Four Man Months

167. A soil scientist with 5 years experience of working with extensive soils or land resources databases, and experience in setting up GIS and image processing facilities on PC's or workstations, would be needed.

168. He, or she, would be required to:

- Work with pedologists and data base/GIS technical and programming staff of the Ministry of Agriculture in reviewing data base, GIS and image processing requirements of the Department of Forestry and Range to support soils and land use monitoring and evaluation for PRIME, and advise accordingly;
- Implement improvements in the existing data base and GIS procedures, as required;
- Advise on new developments in computer operating systems and GIS and liaise with software suppliers regarding maintenance and upgrades of software; and
- Liaise with RJGC and National Information System on making land resources data more widely available in ArcInfo, as well as in SPANS/DXF formats.

Soils and Land Use Specialist for Three Man Months

169. A soil scientist with ten years experience of working in soil survey and land evaluation in arid, semi-arid or Mediterranean areas would be needed. He, or she, must have extensive

knowledge of both physical and chemical properties of soils, climatic parameters and of quantitative land evaluation concepts together with experience of using computers for data processing.

170. He, or she, would be required to:

- Work with the pedologists and data base/GIS specialists in the Ministry of Agriculture and with PRIME;
- Oversee additional soil survey requirements at semi-detailed level and, in conjunction with Range Division, develop a land suitability classification for rangeland uses;
- Work with SLUD to carry out land suitability for all areas mapped at semi-detailed level, including sample areas from Level 1 studies;
- Recommend appropriate means by which rangeland suitability may be assessed for areas mapped only at reconnaissance level; and
- Arrange for automatic suitability assessment using JOSCIS.

Soil and Water Management Specialist for Six Man Months

171. The post would require a soil scientist with five years experience of working in soil and water management research in arid, semi-arid or Mediterranean areas. He, or she, must have extensive knowledge of both physical and hydrological properties of soils, climatic parameters and of quantitative land evaluation concepts, together with experience of using computers for data processing. Specific experience of soil erosion investigations and monitoring would be a distinct advantage.

172. The appointee's main task would be to develop an investigation programme in soil water balance and soil erosion in conjunction with pedologists, a meteorologist and hydrologist ,drawing together skills available in different Ministries.

173. This would involve:

- recommending a field method for measuring hydraulic conductivity for both moist and wet soil conditions;
- recommending procedures for assessing erosivity of rainfall and soil erodibility using runoff and sediment collectors for calibration purposes; and
- incorporating a soil water budget model for assessing soil water availability in rangeland areas, and making soil water measurements for validation purposes.

174. He, or she, would also be required to interpret soil water and erosion data to provide PRIME with information about land degradation for monitoring rangeland conditions.

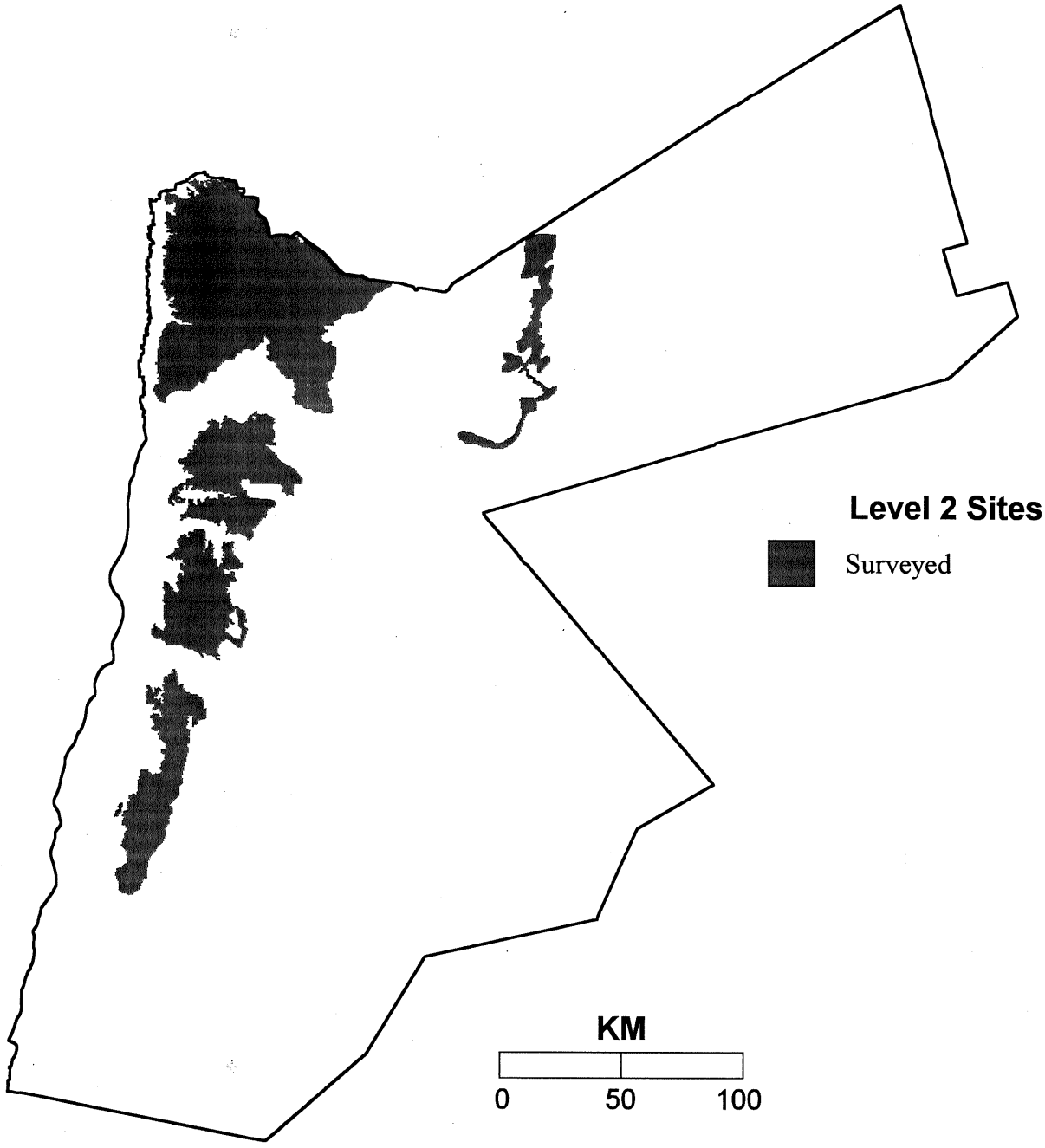
Land Use Specialist for One Man Month

175. A soil scientist with ten years experience of working in land evaluation or land use planning in arid, semi-arid or Mediterranean areas would be required. He, or she, must have extensive knowledge of soils and climatic parameters affecting land use together with experience of using computers for data processing.

176. He, or she, would be required to:

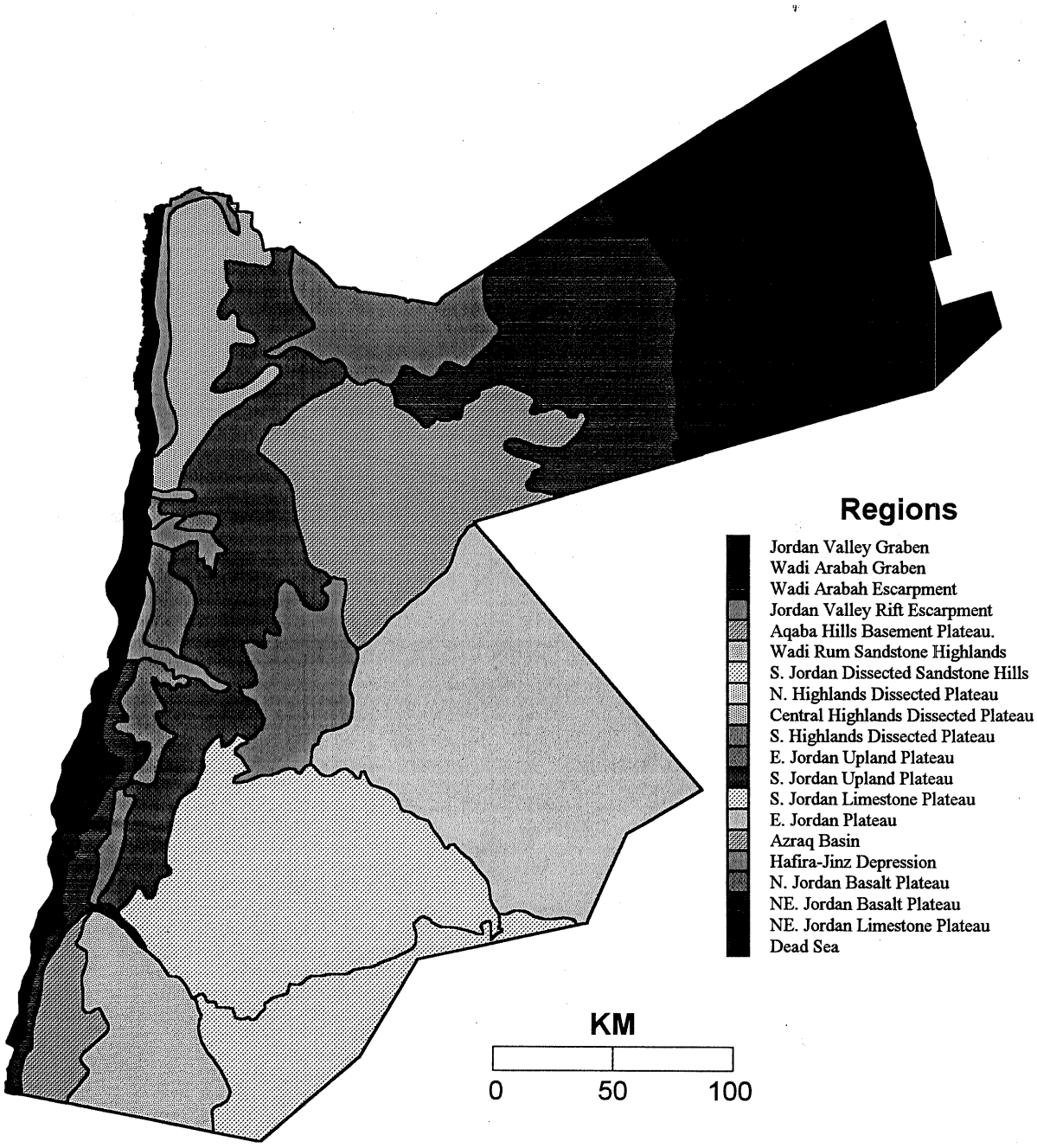
- Focus the attention of pedologists in the Ministry of Agriculture (SLUD) on the analysis of older photographs and records, to determine relationships between climate, land use and soils.
- Recommend analytical methods for soil chemical analysis aimed at monitoring trends in soil fertility; and
- Advise PRIME on management practices and use planning requirements.

Figure A3.1: Level 2 Soils Survey Study Areas



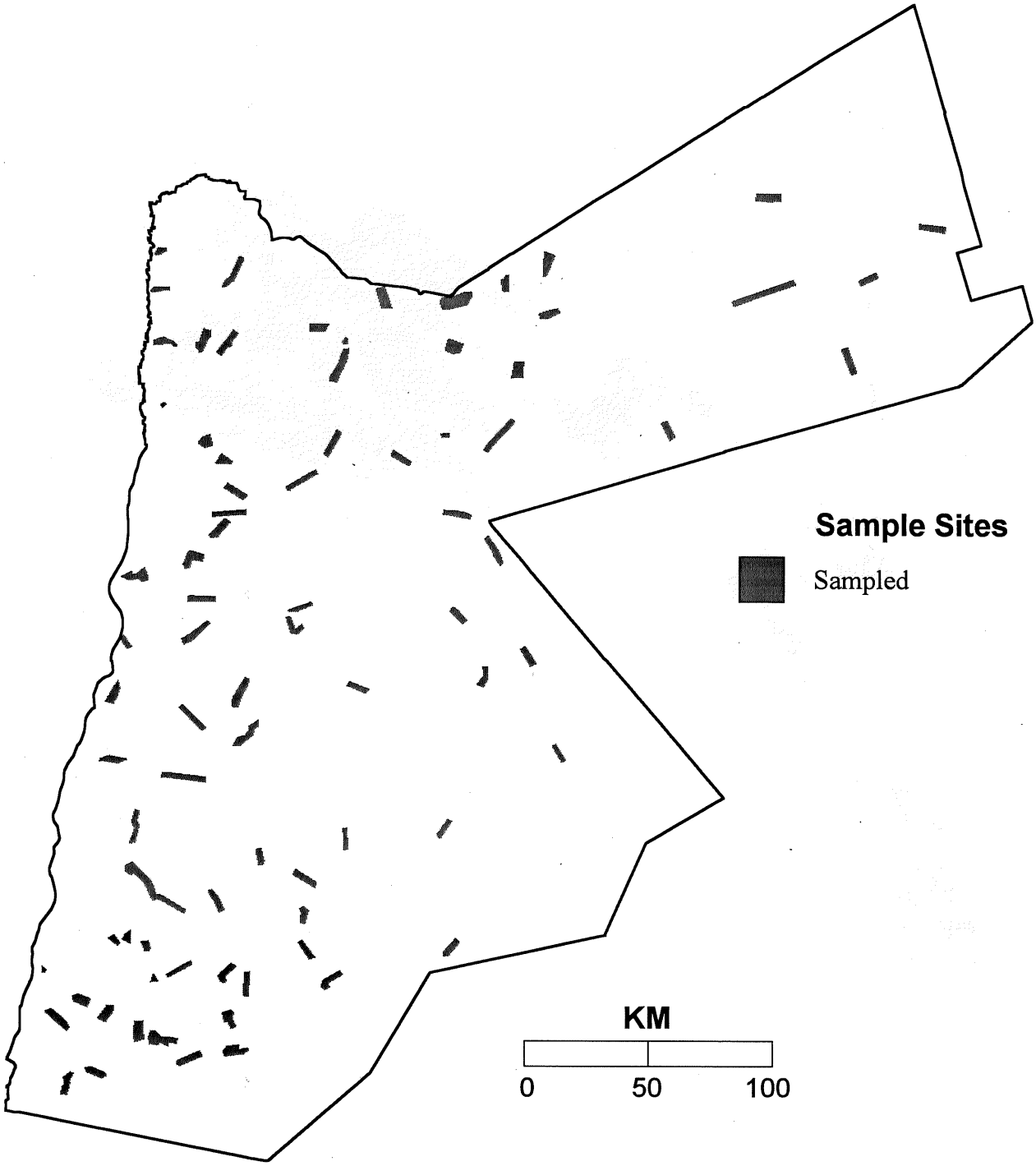
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A3.2: Physiographic Land Regions



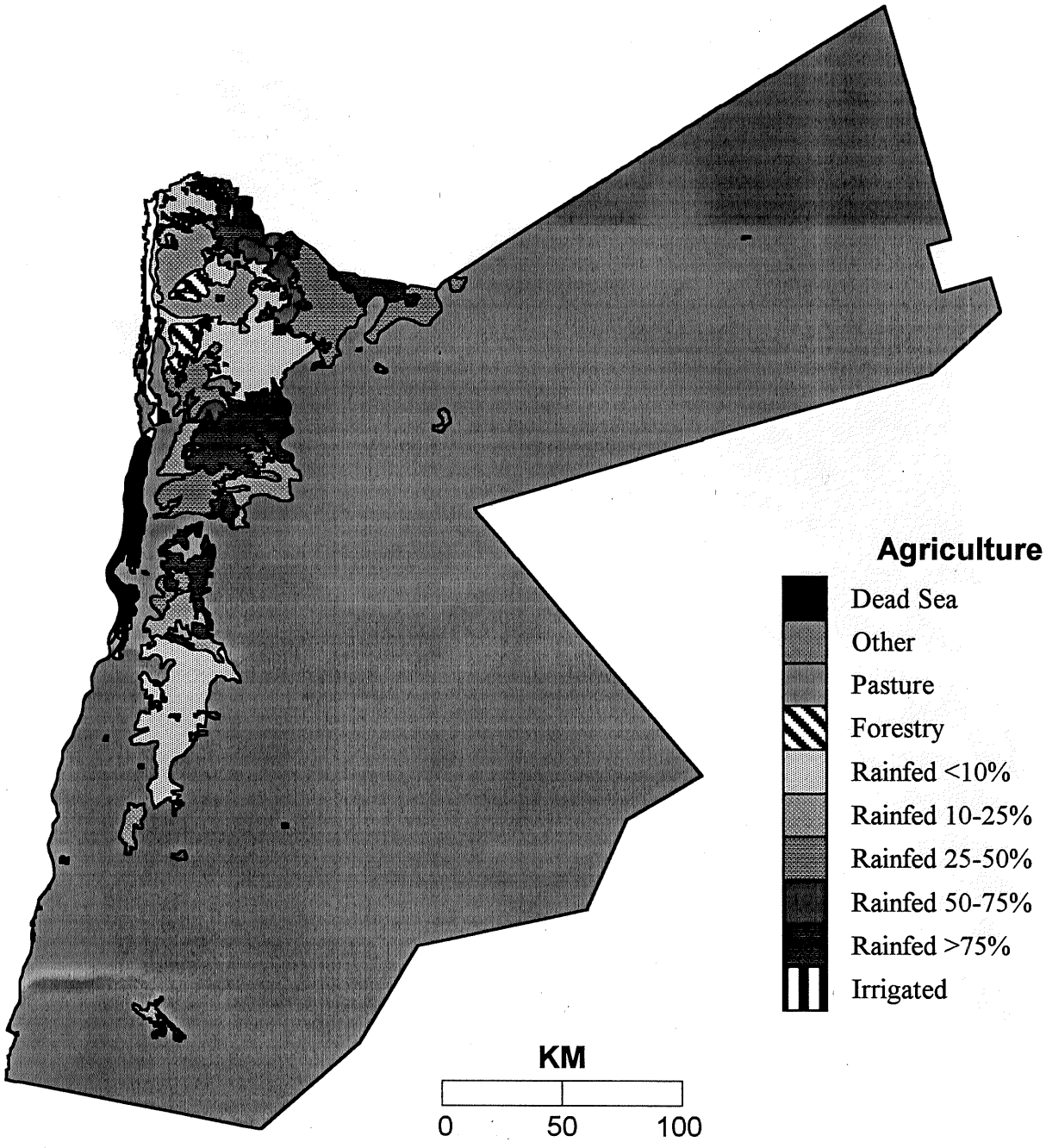
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A3.3: Level 1 Soil Survey Sample Areas



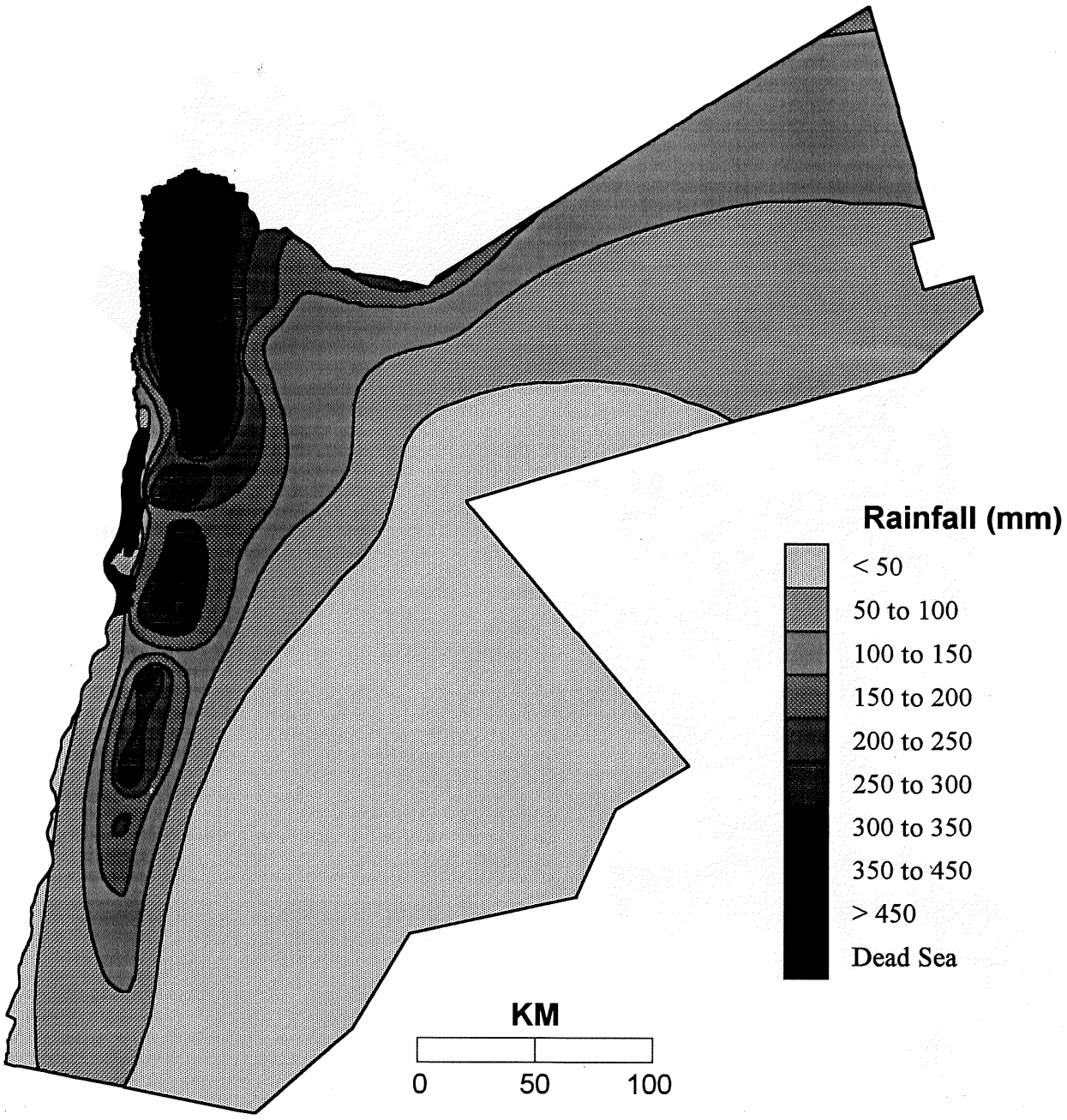
Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A3.4: Agricultural Land Use



Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

Figure A3.5: Annual Precipitation



Modified from: JOSCIS database, Soils and Land Use Division, Ministry of Agriculture, Amman

The Hashemite Kingdom of Jordan

National Programme for Range Rehabilitation and Development

Pastoral Resources Assessment, Monitoring and Co-Ordinating Project

ANNEX 4: LIVESTOCK

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

1. Following the preparation of the formulation report (IFAD, 1993) of the proposed National Programme for Range Rehabilitation and Development a Mission visited Jordan to prepare a Pastoral Resources Assessment and Monitoring Component. The Mission objectives were:

- (1) to identify and evaluate information concerning pastoral rangeland and livestock related resources in Jordan and to assess specific areas where relevant data are inadequate or unreliable; and
- (2) to evaluate resource assessment and monitoring requirements and identify priorities for institutional strengthening.

2. The main report of this Mission identifies a technical assistance Project which would be implemented by a Pastoral Resources Information and Monitoring and Evaluation Unit (PRIME), specifically established for the purpose.

3. This Annex was prepared by the Team Leader, who was required to:

- Assess present livestock population and production statistics, and current in-country capabilities and requirements for updating and monitoring such figures;
- Identify and design livestock population assessment and future monitoring requirements, focusing particularly on the establishment of short-term trends in livestock population numbers, so that the desired future de-stocking can be tracked and quantified;
- The assessment of in-country capabilities of survey and analysis;
- In conjunction with other Mission members, assess and evaluate in-country remote sensing capabilities and requirements.

4. The available information and facilities relating to livestock statistics are reviewed, and found lacking in several respects. Studies have been designed to fill these gaps. Available remote sensing capabilities are considered in other Annexes, to which the consultant provided input where appropriate. An overview of Information Exchange capabilities has been included in Annex 1.

5. This Annex also contains input from the Institutional Strengthening and Capacity Building Specialist concerning livestock marketing and socio-economic information.

6. Discussions were held with the following:

- Ministry of Agriculture: Dept of Forestry and Range; Veterinary Dept; Soils and Land Use Division; Monitoring and Evaluation Division;
- Department of Statistics, Ministry of Planning;
- Royal Jordanian Geographic Centre;
- Higher Council for Science and Technology - National Information Centre; Jordan Badia Research and Development Programme;
- University of Jordan, Faculty of Agriculture
- Jordan Co-operative Society;
- ICARDA; UNEP; Royal Jordanian Airlines (Arab Wings).

AVAILABLE INFORMATION AND EXPERTISE

LIVESTOCK

7. A considerable amount of information on livestock is available, primarily from the Department of Statistics (DoS), which conducted a Census in 1991, followed up by bi-annual sample surveys in April and October each year. The Census methodology was based on village owner enumeration, whereby, on October 1st, all livestock owners were required to report to one of 1,200 counting centres around the country, and have their flocks counted by DoS enumerators. The sample surveys covered some 3,000 owners, selected according the Probability Proportional to Size (PPS) criterion. The numbers claimed by each owner are compared with records for the same individual from the previous enumeration, and a trend established which is then applied on a country wide basis.

8. The results of these assessments are generally available between 6 months and a year after the field work is conducted. Thus, the 1994 data were being finalised during the Mission's visit to Jordan in July 1995. Relevant details of the surveys are given in the appropriate sections below.

9. The other major source of primary livestock data is the Veterinary Department of the MoA, which conducts extensive monitoring of animal health and selected productivity and management related parameters. Substantial numbers of animals are routinely assessed - the 1994 report states that, during that year, 3,300 sheep flocks comprising 526,000 animals, and 3,120 goat flocks containing 157,000 head, were visited.

10. Various elements of this information are evaluated in the following sections. Though information about equines and camels is available, their population levels are very low. Cattle are almost exclusively reared intensively. As a result the impact of these species on the rangeland is minimal, and so the following discussion is confined to small ruminants.

Table A4.1: DoS Livestock Census - Animal Number Data Types Published - Oct. 1991

Number of Animals by:		
	Species	Cattle, Sheep, Goats, Camels, Horses, Donkeys
	Breed	Sheep: Baladi, Najdi; Crosses; Kuios and Foreign Goats: Baladi, Shami, Crosses, Foreign Cattle: Baladi, Holland, Shami, Crosses
	Sex	Male, Female
	Age	Sheep and Goats: < 1yr; >1 yr, Cattle: < 1yr; 1-2yrs; >2yrs
	Average Holding Size	
	Purpose of Keeping	Fattening, Breeding, Trade
	Holder Category	Residents and Non residents
	Land Ownership	Land Owners, Non Land Owners
	Nationality	Jordanian, Non-Jordanian, Temporary Passport Holders, Saudi, Syrian, Iraqi, Palestinian, Egyptian, Other
	Governorate	
Number of Holders by		
	Residency	Residents and Non residents
	Land Ownership	Land Owners, Non Land Owners
	Nationality	Jordanian, Non-Jordanian, Temporary Passport Holders, Saudi, Syrian, Iraqi, Palestinian, Egyptian, Other
	Governorate	

A Complete Enumeration of For Named Owners in approx. 1,200 Counting Centres

Numbers

11. The data currently available from the DoS surveys on national livestock numbers are extensive and regularly collected. The categories of information acquired are shown in Tables A4.1 and 2.

Table A4.2: DoS Sample Survey Animal Number Data Types Published: 1992 - 1994, April and November

Number of Animals by:		
	Species	Cattle, Sheep, Goats
	Breed	Sheep: Baladi, Najdi; Crosses; Kuios and Foreign Goats: Baladi, Shami, Crosses, Foreign Cattle: Baladi, Holland, Shami, Crosses
	Sex	Male, Female
	Age	Sheep and Goats: < 1yr; >1 yr, Cattle: < 1yr; 1-2yrs; >2 yrs
	Governorate	
Number of New Born and Mortality for Full Year by:		
	Governorate	
	Animal Species	Cattle, Sheep Goats

For approximately 3000 owners selected from 1991 Census respondents

12. Despite the detail they contain, the figures are have been subject to considerable debate, largely because they differ significantly from Ministry of Agriculture estimates which are derived from vaccination records. As can be seen from Table A4.3, below, part of the difference comes from a degree of apparent confusion on the part of MoA as to which figures refer to which years, which is possibly more likely to be a clerical error than any real difference in interpretation.

Table A4.3: Livestock Numbers: 1989-1994.

	Ministry of Agriculture				Department of Statistics			
Year	**Sheep**	**Goats**	**Cattle**	**Camels**	**Sheep**	**Goats**	**Cattle**	**Camels**
1989	1,523,000	474,950	25,133	18,254				
1990	1,556,000	479,000	37,557	8,330				
Oct-91	2,671,317	1,079,363	64,150	32,155	2,671,317	1,079,363	64,150	32,155
1992	2,671,317	1,079,363	64,150	32,155	2,878,130	1,151,025	64,199	30,516
Apr-93	2,878,132	1,151,025	64,199		2,483,941	873,194	56,700	
Nov-93					2,211,410	767,824	61,371	
1994	2,483,941	873,194	56,700					

Sources: Ministry of Agriculture and Department of Statistics

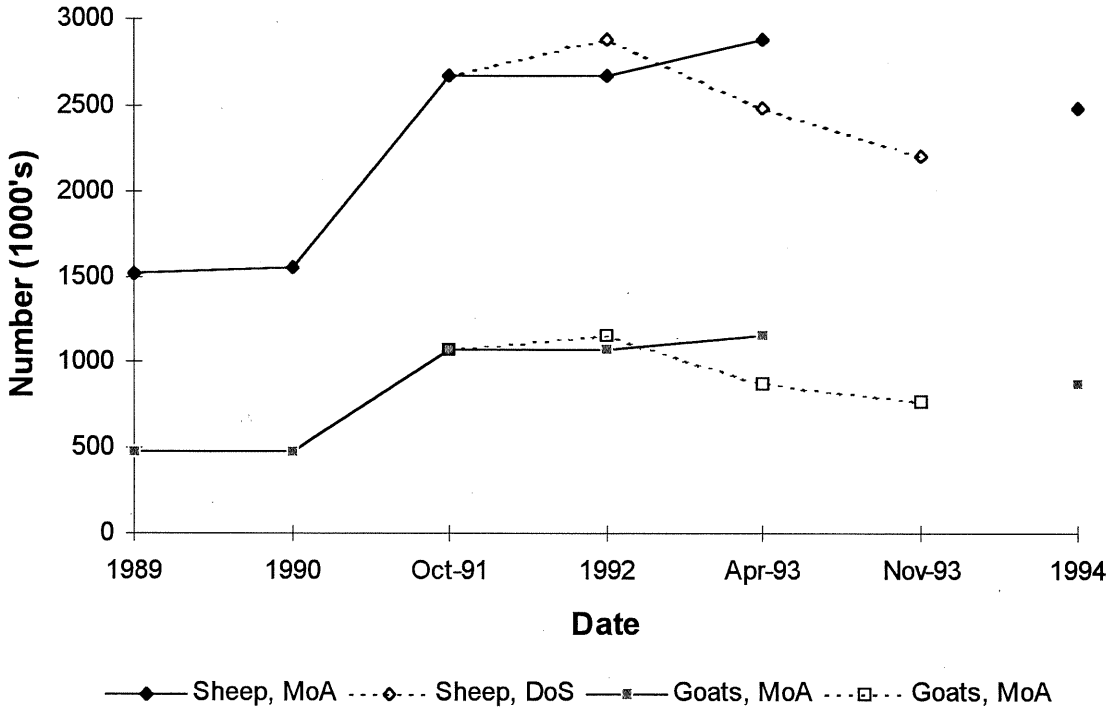
13. However, there is also some disagreement as to the validity of the marked rise in postulated animal numbers recorded for 1991, derived from the DoS Livestock Census. It is the Mission's understanding that prior to the 1991 census, official figures were largely derived from vaccination records, or sample surveys, as opposed to the more rigorous techniques used since then. Thus, the results could reflect a change in methodology rather than a real change in numbers.

14. There is also some scepticism about the 1991 census methodology. The owners who reported to the counting centres were given certificates which allowed them to claim the

subsidies available on imported feed. Though a number of precautionary measures were put in place - e.g. police monitoring, animal marking, enumerator checking - the incentives for manipulating the figures remained, and there is some doubt that the recorded figures are accurate. They may be overestimates, if counts were actively inflated, though conversely, they may be underestimates for the more remote areas, where herd owners failed to report to the counting centres. Further, there are thought to be substantial numbers of stock owners from neighbouring countries migrating through Jordan, either following the pasture, or involved in illegal trade. It is unlikely that these animals will have been brought to the counting centres.

15. Owners questioned during the Sample Surveys, conducted since 1991, are not, however, given subsidy certificates, which may remove the incentive to inflate the figures. This may account for the drop in livestock populations recorded since 1991 (Figure A4.1).

Figure A4.1: Animal Numbers, 1989-1994



Sources: Ministry of Agriculture and Department of Statistics, Amman

16. The decline in animal numbers estimated by DoS has been more or less universal for all species, and appears to be fairly substantial. If it is real, then the implication is that livestock owners are reducing their stock numbers significantly - perhaps in response to the removal of feed subsidies. If so, then the 'destocking' recommended for the proposed Development Programme is already in train. Unfortunately, however, it is not possible to state with any assurance that the decline in livestock population is not an artefact of assessment methodology.

17. It should, however, be pointed out that any limitations in these data are more related to the methodology used to collect it rather than the analytical expertise of the personnel involved. Livestock data are notoriously difficult to collect using ground based techniques, unless there is a universal registry of the type common in, for example, the European Union. DoS staff are statistically skilled and have access to substantial and complex data processing

equipment, which is also used to process and store the human population census records, as well as detailed statistics on livestock crop production.

Distributions

18. Whether the livestock population figures are accurate or not, they cannot be used to establish livestock distributions on any but the grossest scale. DoS publishes the figures by Governorate (Table A4.4), which can be represented cartographically as shown in Figure A4.2. Though these maps do confirm the general impression that sheep and goat numbers have declined according to the data, in all but one Governorate, they could very easily be misleading. For example, the increase in sheep densities in Balqa Governorate is unlikely to be limited to the borders of the administrative unit, and may very well overflow into neighbouring areas.

Table A4.4: Comparison of Animal Numbers by Governorate for 1991 and 1993.

Governorate	Sheep			Goats			Cattle		
	Oct-91	Nov-93	% Diff	Oct-91	Nov-93	% Diff	Oct-91	Nov-93	% Diff
Amman	558,444	510,019	-8.7	211,982	132,204	-37.6	9,036	6,976	-22.8
Zarqa	353,654	322,446	-8.8	77,649	62,453	-19.6	13,211	21,113	59.8
Irbid	239,687	193,397	-19.3	176,892	115,691	-34.6	24,663	21,351	-13.4
Mafraq	743,720	433,932	-41.7	119,612	63,730	-46.7	5,632	4,393	-22.0
Balqa	141,699	160,853	13.5	121,349	109,019	-10.2	9,872	6,73	-31.8
Karak	217,550	214,706	-1.3	125,906	90,466	-28.1	1,017	0,652	-35.9
Tafeilah	70,398	68,183	-3.1	50,596	52,778	4.3	0,092	0	-100.0
Ma'an	346,165	307,874	-11.1	195,377	141,484	-27.6	0,627	0,155	-75.3
Total	**2671,317**	**2211,410**	**-17.2**	**1079,363**	**767,825**	**-28.9**	**64,150**	**61,370**	**-4.3**

Source: Department of Statistics, Amman

19. Some of these problems could undoubtedly be overcome by using smaller map units - in theory, the data are available for each named owner, at each village counting centre. However, the Department is reluctant to provide the figures at this level in case respondent confidentiality is compromised, unless the names are removed from the records.

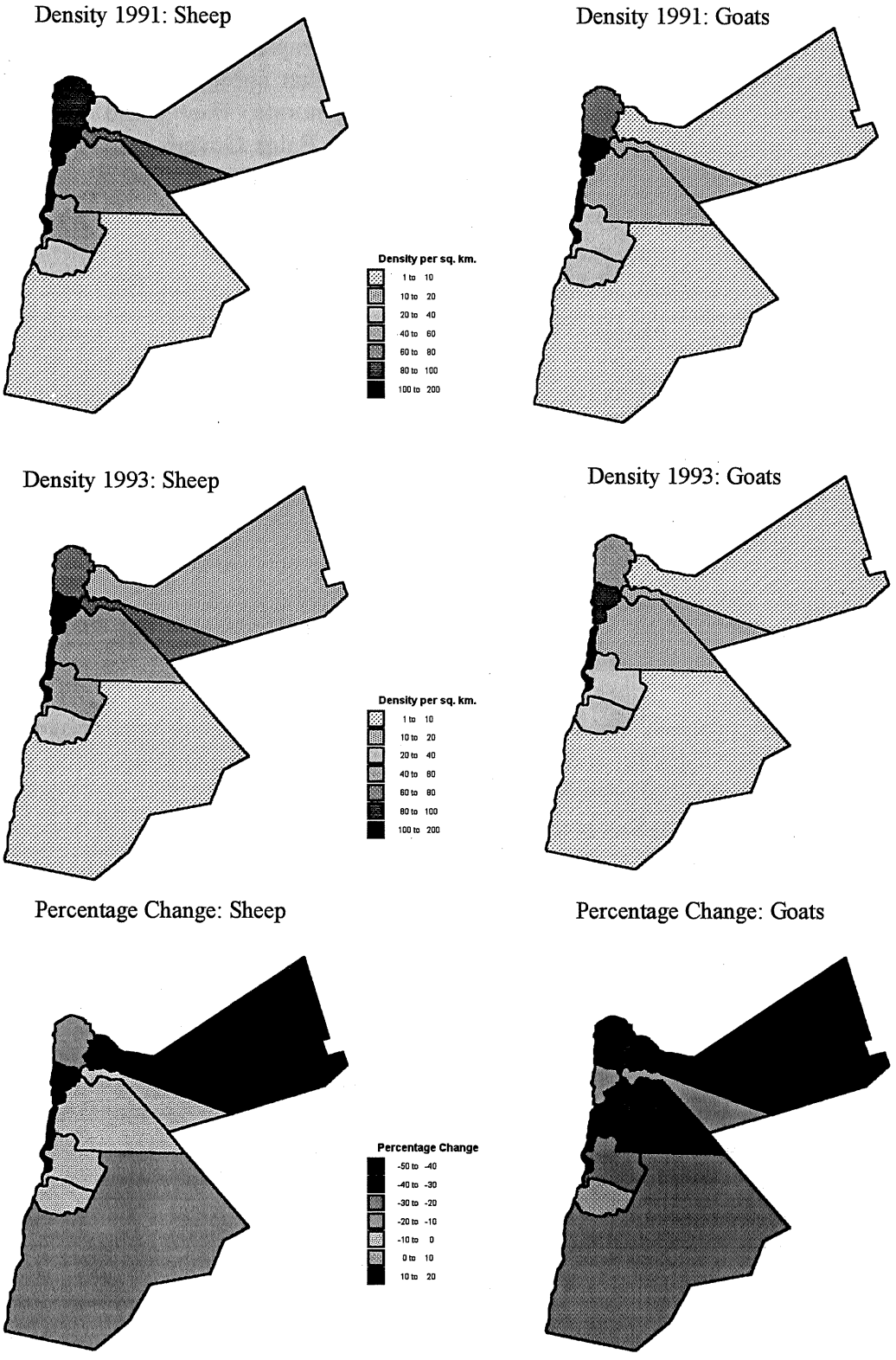
20. Further, even if the data were released, DoS have not geo-referenced the counting centre locations, so even distribution data at the village level could only be produced if efforts were made to identify and attach geographical co-ordinates to the records. Efforts were made in 1991, via FAO short term technical assistance, and though staff were trained in GIS techniques, these efforts have yet to be taken to completion.

21. Animal numbers for Census counting centres cannot, however, be used to assess detailed animal distributions. Nor can the sample data for 1992 - 1994 be interrogated to provide reliable comparative distribution data. This is because the 'catchment' area of each counting centre cannot be precisely defined, nor can the animals be accurately located within each 'catchment'. Such problems are obviously more relevant in the more remote areas, where counting centres are more widely dispersed.

22. As a result, with the data currently available, it is impossible to relate livestock distribution to the presence of rangeland or cropping and so the degree of grazing resource utilisation cannot be ascertained. In addition, it is not possible to assess changes in animal distributions at any meaningful level. Thus, animal movements cannot be related to changes in rangeland condition, the duration of grazing, or, indeed, to variations in cropping patterns. This precludes any analysis of either livestock movement, or its distribution relative to

rangeland or crop resources. Such analysis is essential, if the pressure on natural grazing or extensively planted farmland is to be assessed effectively.

Figure A4.2: Sheep and Goat Densities, 1991 & 1993



Derived from Department of Statistics Data

Herd Productivity

23. The available DoS data on livestock also include a substantial tranche of herd productivity information (see Tables A4.5 and A4.6). Some of these data are independently assessed by the Veterinary Department, who informed the Mission that their findings generally corroborate those of the DoS.

24. Given that such information is usually collected by inspection and by interview of a representative sample of animal herds, and given that DoS Census and Sample surveys involve a minimum of 3,000 respondents, it seems probable that the official figures are reliable. Also, it is difficult to envisage any incentive to falsify these data, even if the provision of a feed subsidy certificate relating to herd numbers is consequent upon owner participation in the Census process. Thus, even if herd numbers are inflated, there seems to be little reason to fabricate or modify the proportions of different sexes or age classes. The statistics available for these parameters are, therefore, in the Mission's opinion, adequate for most purposes, and additional data collection would not be required to provide reliable national statistics.

25. That said, a comparison of the published results from the 1991 DoS Census, the 1993 DoS Sample Survey, and the 1994 Veterinary Department figures do reveal some rather startling contrasts (Tables A4.5 and 4.6 in numbers of animals, and Figures 4.3 and 4.4 as percentages, below). From the DoS data, though sex ratios for goats changed little, the 1993 figures suggest a relatively substantial increase in the number of male sheep. The Veterinary Department information appears to continue this trend.

Figure A4.3: Sheep Herd Structures (%), 1991 & 1993

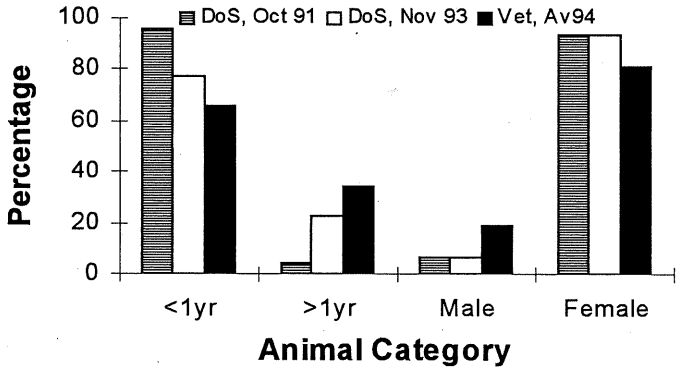


Table A4.5: Sheep Herd Structures, 1991 & 1993

	Oct-91	Nov-93
<1yr	2,551,480	1,703,780
>1yr	119,840	507,630
Male	176,250	151,880
Female	2,495,070	2,059,530

Sources: Department of Statistics, Veterinary Department, Amman

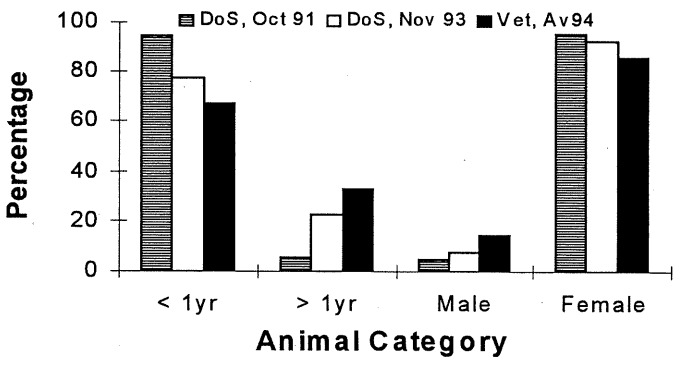


Figure A4.4: Goat Herd Structures (%), 1991 & 1993

Table A4.6: Goat Herd Structures 1991 & 1993.

	Oct-91	Nov-93
< 1yr	1,023,000	595,690
> 1yr	56,400	172,130
Male	52,500	56,490
Female	1,026,900	711,340

26. More significantly, the proportion of both sheep and goats over a year old appears to have increased by a factor of four in the two years between the DoS surveys. The figures thus suggest that, in late 1993, over 20% of the animals present were more than 12 months old. If the population figures are reliable, this change is due to a substantial reduction in the numbers of youngstock, alongside a marked rise in the numbers of older animals.

27. As the two counts were both conducted in late autumn, it seems unlikely that the disparity between the two sets of figures can be ascribed to seasonal variations, which suggests that the productivity levels have indeed changed, and in a direction which tends to reduce herd productivity, and so is likely to impose more pressure on limited grazing resources. However, a definitive interpretation of such data relies on accurate population assessments, which may, as repeatedly pointed out in these paragraphs, not be available.

28. Again, as with the sex ratio figures, the Veterinary Department age structure data for 1994 appear to continue this trend further. It can, however, be invidious to compare series of data with little geographical referencing. It is likely that the Veterinary figures are derived from a site coverage less broad than that of DoS - thus regional variation may lead to substantial biases in the data produced. In the absence of details of the survey site locations, a reliable comparison cannot be made.

29. Fertility data are collected by the Veterinary Department of the MoA, and assembled in an annual report for dissemination to the Department of Statistics, and to a range of international agencies. These figures are summarised in Table A4.7, below

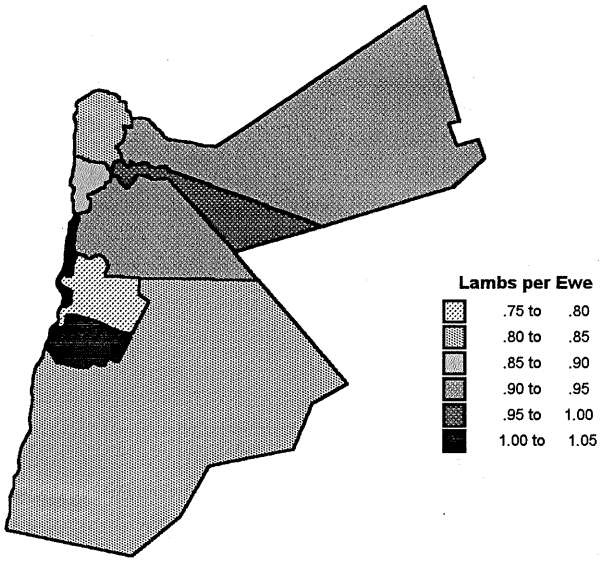
Table A4.7: Fertility Parameters for Small Ruminant Species, 1994.

Parameter	Sheep	Goats
% Pregnant	96.1	96.2
% Aborting	1.5	3.0
% Stillbirths	0.6	1.0
% Lambing/Kidding	94.1	92.2
Births/female	0.96	1.03
% Twins	2.8	12.8
% Viable	99.5	98.6

Source: Epidemiology and Production Monitoring Division, Veterinary Department, MoA, Amman

30. An outstanding feature of these figures is the extremely low twinning rates recorded for both species - even drought stressed small ruminants in other dryland areas commonly have substantially higher proflicacy rates, than the figures reported here. They are, however, corroborated, in general terms, by other sources (e.g. the JCO, BRDP - see section on Health, below), which suggests that the figures are accurate enough to provide a national overview.

Figure A4.5: Lambs per Ewe, DoS, 1993



31. Some of these figures can be compared with data produced for 1993 by DoS - an example is the number of lambs produced per ewe - the Veterinary Department's national figure is 0.96, that for DoS is 0.89. Given the likely contrast between sample site distribution, and given the regional variability (see Figure A4.5), and the possible annual variations, these two sets of data are sufficiently close to suggest that both are reliable at the national level.

Production and Economic Data

32. The bi-annual DoS Sample Surveys produce a plethora of information relating to inputs and outputs. These are summarised in Table A4.8 below, and include: capital formation and fixed assets, farm-gate prices and costs, import and export levels for both animals and feed, as well as the input/output information required to estimate value added during each year.

33. Two examples are given of the data which can be extracted from this information (See Figures A4.6 and A4.7, below):

- The prices of local and imported lambs during recent years, illustrating the relatively high cost of local animals, and the levelling off of a recent substantial rise in prices.
- The terms of trade between local livestock and imported wheat, which shows livestock to be at an increasing disadvantage in recent years.

Figure A4.6: Imported and Local Lamb Prices in Recent Years

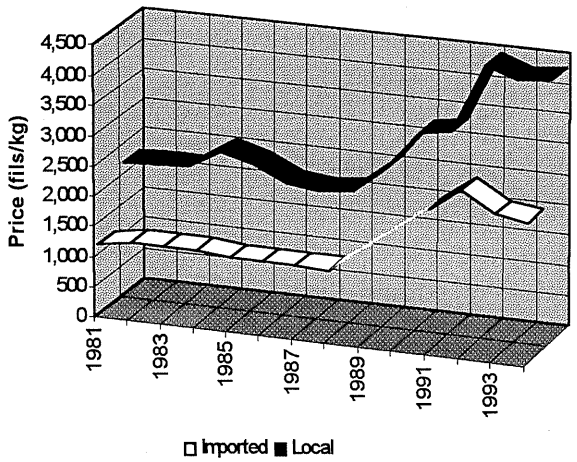


Figure A4.7: Terms of Trade - Imported Wheat/Livestock

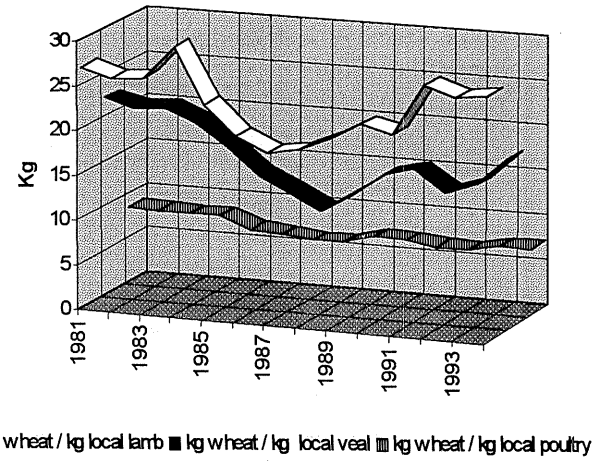


Table A4.8: DoS Sample Survey Additional Data Types Published: 1992 - 1994

Current Number of Employees by:		
	Holding Type	Sheep and Goat Holdings; Cattle Holdings Broiler Farms; Layer Farms, Parent Stock Farms; Hatcheries
	Age	12-16; Above 16
	Kind of Labour	Household Members; Casual Employees Seasonal Employees; Permanent Employees
	Nationality	Jordanian, Non-Jordanian,
	Governorate	
Compensation and Number of Employees for Full Year : Social Security Contributions, Wages and Salaries, Payments in Kind, Other Benefits by:		
	Kind of Labour	Casual Employees Seasonal Employees; Permanent Employees
Value of Material Inputs - Intermediate Goods Used in Production, Intermediate Goods Sold without Processing, Year -end and Start of Year Stocks, Farm Own Production, Goods Purchased by:		
	Holding Type	Sheep and Goat Holdings; Cattle Holdings Broiler Farms; Layer Farms, Parent Stock Farms; Hatcheries
	Items	Water, Electricity, Fuel, Concentrates, Salt, Wood Straw, Calcium, Packaging, Veterinary Medicines Roughage, Green Forage
	Bought in Stock	Broiler Chicks, Hatchery Eggs Fattening Goats, Fattening Sheep
Value of Other Expenditures - Farm Rent; Building Rent; Transport Rental; Machinery Rental; Maintenance of Buildings; Bank Charges; Shipping, Transport and Storage Expenses; Insurance; Auditing; Advertising; co-operative Fees; Technical Supervision; Transportation; Loans Interest; Grants, License Fees, Telecommunications; Others by:		
	Holding Type	Sheep and Goat Holdings; Cattle Holdings Broiler Farms; Layer Farms, Parent Stock Farms; Hatcheries
Livestock Production Value and Number - Start of Year end Stocks for Sale and for Consumption; Annual Sales and Production for:.		
	Sheep and Goat Holdings;	New Born Animals, New Born Draught Animals Fattening Animals, Milk, Ghee, Sour Milk, Wool and Mohair Layer Chickens, Pigeons, Table Eggs
	Cattle Holdings	New Born, Fattening Cattle, Milk, Organic Manure
	Broiler Farms;	Broilers, Organic Manure
	Layer Farms,	Table Eggs, Layers, Organic Manure
	Parent Stock Farms;	Hatchery Eggs, Parent Stock, Organic Manure
	Hatcheries	Chicks
Other Revenues and Services to Others - Agricultural Services, Building Rents, Equipment and Machine Rents; Land Rent.		
Wells and Water Stores		
Main Livestock Exports and Imports by Number or Weight and Value for:		
	Live Horses, Cattle, Sheep and Goats, Chick less than 24hrs, Poultry, Others Fresh and Frozen Beef; Fresh and Frozen Chicken, Offal, Chicken Livers Fresh, Frozen, or Salted Fish, Shrimps Hatchery Eggs, Table Eggs, Powdered Milk Concentrated Milk, Powdered Milk; Butter, Fresh Cream, Ghee, Sour Milk White, Kashkawan and other Cheese; Honey Veterinary Medicines Barley, Maize, Bran, Feed Concentrates, Prepared Forages, Straw	
Farm Gate Prices of:		
	Sheep, Goats, Barley, Bran, Straw, Concentrates	

For approximately 3,000 owners selected from 1991 Census respondents

34. This information certainly appears to form a comprehensive base for most planning purposes at a national level - assuming that the population levels used as multipliers for the summary tables are accurate (see earlier discussions). Again, however, there is little in the way of regional breakdown in the published data beyond the level of Governorate, which would restrict the usefulness of the data for identifying local variability, or targeting specific implementations.

35. There are, however, a number of inadequacies in the current knowledge base these data represent. Little information is available on livestock marketing at the household level particularly concerning the reasons for livestock sales - whether they are production or market led - and the relative importance of livestock within the household economy is a topic about which the Mission was unable to find any concrete assessments.

36. It should be noted that some of this might be obtainable by delving further into DoS records and by detailed analysis of their livestock and cropping information.

37. Similarly, the number of animals in intensive feedlots is poorly documented. If, as considered in the Formulation Report, intensification and feed-lotting is seen as a mechanism for destocking, reliable information would be needed on the baseline levels of this type of livestock management, particularly should the Development Programme be implemented. In addition, any changes in these levels would have to be carefully monitored during the life of the Programme.

Health

38. The Epidemiology and Production Monitoring Division at the Veterinary Department conducts widespread monitoring programmes, is hampered by insufficient data processors, and outdated software. Thus, despite more than adequate technical skills, substantial amounts of data have been collected, but neither processed or analysed because of a bottleneck that would require relatively few additional resources to alleviate. Additional monitoring on a limited scale (20 - 40 herds) is carried out by JCO and BRDP at the Safawi field station.

39. Table A4.9, summarises the incidence of a number of diseases in 1991, 1992, and 1994, as reported by the Veterinary Department. The figures suggest, among other things, that the incidence of infectious diseases is low. Despite the scale of the surveys used to collect the information, these statistics are, however, disputed in some quarters.

40. For example, some institutes (e.g. JCO) hold that animal health is a major problem throughout the country - particularly Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD) and Blue Tongue in sheep. The Veterinary Department, in contrast, maintains that Blue Tongue and PPR are rare in most parts of the country and are only problematic under feedlot conditions, where animals from different herds are concentrated at fixed locations for extended periods, thus facilitating transmission of disease from infected animals.

41. A major reason for this disagreement is the widespread prevalence of sub-clinical symptoms, particularly for PPR and Blue Tongue in sheep, which are not generally diagnosed by the Veterinary Department surveys. Specific MoA serological studies report that 23% of animals in Jordanian flocks, tested in 1992, were sero-positive for PPR, and up to 75% in flocks migrating from neighbouring countries. The Veterinary Department also reports that 33% of sheep in the northern part of the country were sero-positive for Blue Tongue in the early eighties. This compares with negligible clinical diagnosis levels for both diseases in both 1992 and 1994.

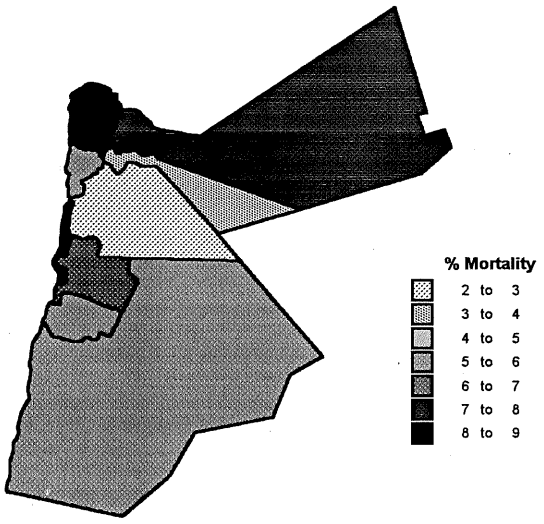
Table A4.9: Sheep and Goat Disease Incidence, 1991 - 1994

	Sheep			Goats		
	1991	1992	1994	1991	1992	1994
No Inspected	623,679	772,530	835,988	230,523	251,022	250,149
% diagnosed:						
Anthrax	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pox	0.2	0.4	<0.1	0.4	<0.1	<0.1
Clostridia	1.1	0.6	<0.1	0.5	0.1	<0.1
Brucellosis	0.2	<0.1	<0.1	0.5	<0.1	0.1
Cutaneous Pustular Dermatitis	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Foot and Mouth (FMD)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pasteurella	<0.1	<0.1	<0.1	0.1	<0.1	
Diarrhoea (adults)	0.5		0.2	1.1		0.7
Diarrhoea (young)	0.3		0.2	0.8		0.4
Intestinal Parasites	4.3		1.2	3.7		1.4
Lungworm	9.0		2.8	11.0		4.2
Respiratory Infection	2.5		0.5	1.9		0.7
Impaction	0.1		<0.1	0.1		<0.1
Poisoning	0.2		<0.1	0.1		<0.1
Foot Rot	<0.1		<0.1	<0.1		<0.1
Arthritis	<0.1		<0.1	0.1		<0.1
Mastitis	0.3		<0.1	0.5		0.2
Tick Fever	3.5		1.3	8.2		2.9
Tick Infestation	4.1		1.4	5.2		3.0
Lice Infestation	4.5		3.9	6.6		5.1
Mange	0.9		1.5	0.6		1.9

Source: Veterinary Department, MoA, Amman

42. This situation is further complicated by the concurrent sub-clinical presence in many flocks of PPR, Blue Tongue and Foot and Mouth Disease. This has a seriously debilitating effect on the animals, and is usually cited as a major reason for the low twinning rates in the country as a whole (see above) and the reduced weight gain achieved in commercial feed-lots. As a result, many stock owners and researchers are sceptical of the Veterinary Department's figures suggesting low prevalence of most infectious diseases, and of the priority assigned to vaccination against towards Foot and Mouth Disease that depends on them.

Figure A4.8: % Mortality in Sheep, 1993



Source: Department of Statistics, Amman

43. Overall mortality data are produced by both the Veterinary Department and DoS. The DoS data for sheep in 1993 are shown in Figure A4.8. Unfortunately the two data sets do not appear to be directly comparable as the former are concerned with deaths caused by clinically diagnosed diseases, whilst the latter refer to all sources of mortality. Provided these restrictions are appreciated, and the figures are interpreted appropriately, there is no

reason to suppose that there are any serious inaccuracies in them. Again, however, the lack of small scale regional information in the published reports reduces the potential uses to which the data can be put.

Livestock Management

44. The recent socio-economic studies have provided an overview of livestock management practices. They have, however, generally been rapid assessments, rather than detailed or long term studies. In particular, the ownership patterns of livestock that utilise the natural rangelands are little understood, as are the perceived constraints affecting livestock production in the more remote regions, in particular the interaction between resident and immigrant stock owners. These factors need to be better appreciated before any substantial rangeland rehabilitation is attempted.

Conclusions

45. The livestock information available in Jordan is extensive, and, with a few exceptions, of sufficient quality and depth to provide a satisfactory basis for continued monitoring and for development planning.

46. There are however some gaps, which require filling and some data which need further elaboration or reanalysis. The most pervasive lack is of high resolution distribution data for livestock. To a degree, this can be overcome by geo-referencing existing DoS data, which would allow for some more detailed regional analysis of livestock production and economic criteria. However, this would still be insufficient to relate livestock numbers to vegetation or land use distributions, and so establish the levels of resource use, because the rangeland and farmland patches are small relative to the sample frames of the existing livestock data (i.e. the areas around each Census counting centre). Such information can only be gathered by assessing livestock numbers at a resolution comparable to the patchiness of the resource base.

47. The validity of the available livestock population estimates also needs assessing, largely because these data are used to calculate a substantial amount of production and economic data at a national and Governorate level. If the basic numbers are wrong, the derived data will also be incorrect.

48. The socio-economic context of livestock keeping, particularly in the more remote areas, needs further study. Relatively little is known about the patterns of ownership, or of the perceived constraints on small ruminant production.

49. Despite the wealth of economic and production data available, there are two important topics which have not, to date, been addressed effectively. Little is known about the household economics of livestock keeping - particularly in relation to the importance of livestock relative to other economic activities, and to the local, regional and international marketing structures. Also there is very little information on the degree to which livestock management practices are intensifying (or otherwise), which would need to be established if the Development Programme be implemented.

50. The last major area of ignorance is whether animal disease - especially at the sub-clinical level - is a local, regional or livestock management related problem, and its likely effect on animal productivity. This should be established as a matter of priority.

51. Five areas of livestock related studies are therefore required:

- An assessment of livestock distributions in relation to rangeland and cropping, alongside a verification of existing population data;
- Geo-referencing existing livestock data held by DoS;
- Further examination of the socio-economic context of livestock management, livestock ownership patterns, and perceived constraints on production;
- An investigation of the role of livestock in the household, including an evaluation of marketing strategies, and animal health monitoring via the medium of detailed herd monitoring,;
- A strengthening of animal health monitoring to permit the analysis of unprocessed data, and expand future capability to permit a special emphasis on the levels of sub-clinical disease;
- An assessment of the current and future levels of feedlotting

52. These studies are expanded upon in the following section.

RECOMMENDED LIVESTOCK RELATED STUDIES

A). LIVESTOCK DISTRIBUTION, MOVEMENT AND MANAGEMENT

Objectives

53. Livestock numbers that would provide high resolution animal distribution or movement data are required. This would be used to establish the baseline levels of rangeland resource utilisation in relation to its actual and potential production, its suitability and its phenology. Once defined, this relationship would be used to predict rangeland utilisation by livestock using remotely sensed vegetation data, and assessments of range suitability derived from the other study components. This process would help to establish the true potential of the rangelands to support livestock, and to define the changes in such potential that might accrue from rangeland rehabilitation measures.

54. In order to link with vegetation or soil derived suitability information, the resolution of livestock distribution data would need to be of the same order of magnitude as satellite imagery or 1:250,000 soil maps. Also, in order to provide movement data relative to range distribution, surveys would have to be repeated at least twice in one year and would be needed for quite large areas in order to accommodate regional variability in rangeland production and extent.

55. A range of socio-economic data is also required, particularly concerning the management of livestock in remote areas.

56. The major objectives of this study would thus be to:

- a) To assess livestock distribution patterns in relation to the availability of range and cropland resources;
- b) To assess livestock movement in relation to changes in the distribution of range and cropland resources;
- c) Using the results from a) and b) above, to assess rangeland resource utilisation by livestock in relation to range and crop land extent, phenology;

- d) To provide independent verification of existing DoS livestock population estimates; and
- e) To investigate socio-economic and economic factors influencing livestock keeping and management in relation to range resource utilisation.

Methodology

Available Alternatives

57. Amongst the primary information required from a livestock survey is an estimate of numbers and a description of distribution patterns. These data should be collected in as short a time as possible, to minimise the effects of animal movement, and should be assembled in such a way as to enable comparisons with both past and future figures.

58. Animal population figures can be derived from a variety of information sources, ranging from administrative records, such as taxation and vaccination returns; to data collected by more scientific and objective methods of assessment, based on ground, or air survey techniques.

59. Population estimates derived from indirect ground census techniques must be treated with caution. Ground transects are also difficult to interpret and are generally considered to be of limited value. Off-road visibility varies with vegetation density; roads and tracks are usually associated with human settlement and cultivation; transect sample data is likely, therefore, to be unrepresentative of the whole area.

60. Ground based census methods of the sort used by DoS rely on accurate enumeration and reliable co-operation of the respondents. Both may be compromised by factors beyond the control of the survey designers or enumerators. Ground based techniques are also very expensive of manpower, equipment and time, especially if a series of livestock population estimates are required within a short period, in order to assess movement patterns, and if the enumerators have to visit remote areas in order to count animals.

61. Attempts have been made in recent years to use satellite imagery and conventional aerial photography to count animals. However, the availability of satellite imagery and the resolution of both are generally such that they are not appropriate for the assessment of livestock populations. High resolution aircraft-mounted video has also been tried in a number of areas, with limited success, as the equipment need to stabilise the video platform is expensive, prone to malfunction, and produces tapes which require a substantial amount of time to analyse.

62. An alternative approach would be the use of low level aerial survey, which provides an objective, rapid and cost-effective means of assessing livestock populations over extensive land areas. One particular technique, known as Systematic Reconnaissance Flights (SRF), has been widely used to assess livestock, wildlife and human habitation from flight levels of between 450-1,500 feet (150-450 meters) above ground. At these heights, visibility is sufficient to differentiate, for example, small ruminants and calves, the ground is rarely obscured by clouds, and, unless the canopy cover is complete, the angle of view is generally sufficient to see under such obstacles as trees.

63. SRF methods are based on sampling between 5 and 20% of the region to be surveyed from the air, so that the entire zone is covered. A wide range of data can be collected, either through visual observation backed up by photographs, or by exclusively photographic means.

From this information, population estimates can be extracted, and distribution maps prepared. In addition, by using specialised computer packages, data from published sources, such as maps, can be entered into the dataset and used to stratify the population figures in any way that may be required.

64. Daily survey flights would be timed to ensure that the majority of the animals were grazing, rather than agglomerated in large groups round the owners' camps. Any such large groups would be both counted by the observers, and photographed in order to double check the accuracy of observer estimates.

65. SRF techniques have been tried and tested in many dryland environments and can provide detailed and reliable estimates of many agricultural and environmental parameters (see Table A4.10). However, it cannot be used to directly collect information concerning such factors as livestock ownership patterns, animal production parameters, or constraints to production, as perceived by farmers or stockholders. These data can only be gathered from ground based studies.

66. A compromise is needed to obtain the sort of information required in Jordan, such as integrated air-ground surveys. These employ SRF to collect the primary quantitative information and establish distribution maps, which, in turn, are used to identify the areas of major significance, such as livestock concentration zones, to which ground teams are dispatched in order to obtain the more detailed information required. This process ensures the optimal use of the available manpower, and minimises the time wasted in close examination of the less important regions.

67. In addition, the ground survey teams can be used to collect information specifically designed to supplement that gathered from the aerial survey. In this way, data available to neither aerial or ground surveys alone can be obtained, by combining the results of the two survey elements.

Table A4.10: Information Typically Collected From The Air

WITHIN THE SAMPLE BAND	
Numbers of	
Animals	
	Cattle, Sheep and Goats, Horses and Donkeys, Camels, Wild animals.
Habitation and Settlements	
	Villages, Rooftops of selected architectural types, Compounds, Tents of selected architectural types,
Other	
	Corrals, Tar Roads, All Weather Roads, Tracks Rivers and Open Water, Wells
WITHIN EACH GRID	
	Presence of Open Water, % Cultivation, % Grassland, % Burned Ground, Gully and Sheet Erosion (0-5) % Open Canopy Woodland, % Savannah Woodland, Grass cover (0-5), Indicator Plant Species Flying Altitude, Direction and Time.

The parameters described are not intended to provide an exhaustive list of the possibilities, but are indicative of those that are commonly collected during surveys.

68. This basic technique has been used in a number of other ways in dryland areas, particularly the Sahel region of Africa. By assessing livestock ownership levels per household together with the number of rooftops per household during ground surveys, and combining these with aerial estimates of rooftop numbers, it is possible to estimate total claimed livestock ownership numbers for any particular area. This may be markedly different to the number of animals present in that region if a high proportion of stock are away on transhumance, a fact which would have considerable significance to the planning of interventions as well as to the quantification of the economic significance of the local livestock sector.

Aerial Survey Sampling Strategies.

69. The essence of SRF rests on systematic flights over the whole survey zone, but using sampling rather than total coverage of the area concerned. A systematic sample from a patchy population ensures that all parts are represented in nearly the right proportions, whereas a random sample may fall in areas of high or low density more often than the proportion of such areas in the population would suggest. Further, a systematic sample provides more or less constant accuracy throughout the sampling frame, unless there are regular and periodic patterns in the population's distribution. This is extremely unlikely to be the case for any natural system. The major consequence of choosing a systematic sampling pattern is that the calculation of the error term is somewhat more complex.

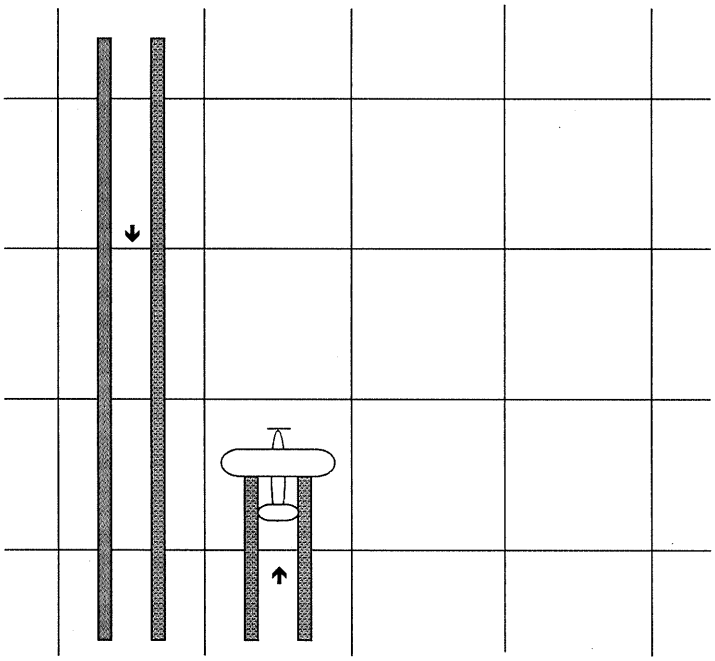
70. As far as stratification is concerned, that is the sampling of different sectors of a survey site at different intensities, there are arguments both for and against. The points in favour of stratification are essentially that areas with low populations can be sampled at low intensity, while those with high numbers can be covered more intensively, and thus with greater precision. This however presupposes some advance knowledge of the distribution of a population within the survey site. It is also complicated by the very real possibility that different parameters have different distribution patterns. The choice of a particular stratified strategy might for example increase the precision of, say, cattle population estimates, but would have the reverse effect as far camels are concerned. Similarly stratification in favour of cultivated land would adversely effect estimates of woodland or forest. Thus, if the provision of overall distribution maps and population estimates for a range of parameters is required, then all the advantages lie with unstratified sampling.

71. In view of these arguments, the basic technique adopted in all the aerial surveys of livestock, habitation and land use has followed standard procedures of Systematic Reconnaissance Flights (SRF), described by Norton-Griffiths (1978) and Clark (1986), in which a series of parallel flight lines are flown over the given region at an equal distance apart. Each flight line is divided into sectors of equal length to form a sampling grid, based on the Universal Transverse Mercator projection.

72. The size of each cell depends on the desired sample intensity for a given survey. The grid cell sizes commonly used have varied from 5x5 kilometres, to 20x20 kilometres, which result in sample percentages of between 5 and 20% according to flying height and strip width.

73. As will be evident from the arguments presented above, standard surveys employ a systematic and unstratified sampling strategy, whereby the aircraft is flown along the centre line of each grid, and observations made from a fixed sample band (Figure A4.9). Large scale examples include both the Kenyan and Nigerian National Livestock Censuses.

Figure A4.9: Aerial Survey Grids

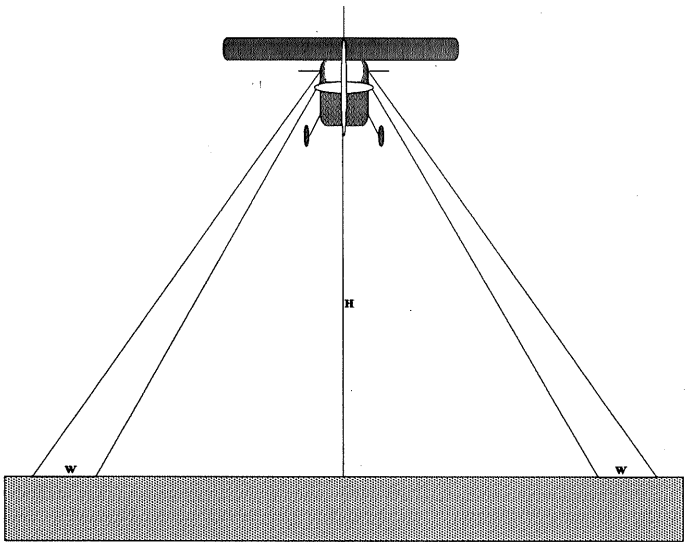


The aircraft flies in parallel lines over the study area, and observers record from fixed sample bands to each side. The flight lines are divided into equal sectors, to create a grid cell lattice, by which each record is located

74. The survey region is thus covered uniformly, so that the data collected is immediately mappable, and relatively easy to interpret. After a survey has been completed, the information is analysed in relation to a range of strata which may derive from the records made during the survey, or from information obtained from ground survey, or extracted from previously published maps.

75. On board the survey aircraft, as well as the pilot, there are usually three experienced observers. The front seat observer, who sits alongside the pilot, is responsible for determining flight line waypoint co-ordinates; maintaining accurate navigation by identification and location of recognisable ground features; recording flight details such as height above ground; informing the other observers at the start and end of each grid; and recording selected environmental characteristics of each grid.

Figure A4.10: Aerial Survey Sampling



Only those herds and settlements which pass through the observation strips are counted and photographed. The strip width (W) is directly proportional to the flying height above ground (H) and is defined by externally mounted viewing frames which are typically set to delineate a band 500m wide at 800 ft above ground or 250m wide at 400ft above ground.

76. The responsibility of the backseat observers is to examine a strip of ground on each side of the aircraft and to record the type and number of animals/dwellings of each category seen within, and only within, his ground strip. The strip on each side of the aircraft is defined by an externally mounted viewing frame, which is adjusted, prior to any survey, so as to give the desired strip width and hence sampling intensity, at a predetermined flying altitude (Figure A4.10).

77. As well as recording what he or she sees, each back seat observer has an automatic 35 mm camera with a 200 mm telephoto and is required, wherever possible, to take photographs of all herds or settlements in excess of ten falling within his ground sampling strip. Comparison of subsequent accurate photocounts with the

estimates recorder by observers during survey allow an individual counting bias to be determined for each parameter recorded. These are used to correct those estimates for which clear photographs were unavailable.

Proposed Surveys

78. Given the methodological constraints discussed above, and despite extensive exploration of the possible ways of adapting existing DoS techniques, no feasible alternative to integrated air and ground survey could be identified that would satisfy the objectives of the proposed studies.

79. It is this proposed to mount low level aerial surveys at two periods during the spring of PY1 - in February, when the rangeland is at its greenest, and again in April, towards the end of the main rangeland grazing period. The surveys would provide assessments of livestock densities at a resolution of 4 km, together with estimates of natural vegetation cover, human habitation, and open water.

80. A ground survey would be conducted during the second of these surveys, designed to assess the ratios of sheep and goats in small ruminant herds observed from the air, as well as estimate the number of animals obscured from the air by, for example, buildings. These would be linked to aerial estimates of habitation, to provide an assessment of 'village animals'. The ground survey teams would also be charged with obtaining socio-economic information, including livestock ownership patterns, animal production parameters, production constraints and details of animal husbandry in the areas surveyed. Survey locations sampling intensity should be decided in the light of the preliminary results of the February aerial survey.

81. This strategy would give two points of reference for rangeland utilisation in relation to livestock numbers, as well as allow for the assessment of the way animals are moved in response to range condition. The second survey would also coincide with one of the bi-annual livestock counts carried out be DoS, and so provide the opportunity to validate their figures.

82. Ideally these surveys would cover the entire rangeland area of the Country, but the resolution required to be compatible with the information collected by the soils, land use and rangeland studies would make such a large survey prohibitively expensive. It is thus proposed that the coverage be limited to Mafraq Governorate, which occupies most of the north and east Country.

83. The specification of an entire Governorate would allow a direct comparison of the survey results with those from the routine DoS survey scheduled for April. In addition, Mafraq contains a wide range of vegetation types and rainfall bands and so is more representative of the Country as whole than most other Governorates.

84. Mafraq is also logistically convenient in that the BRDP's Safawi Field Centre is at its geographical centre. This has an excellent airstrip, and substantial accommodation facilities and is thus ideally located to be the proposed survey base. The Centre is also involved in activities which are compatible with the broad aims of the PRIME's proposed activities, and would be likely to collaborate enthusiastically with the ground survey element of the livestock surveys.

85. The proposed budget allows for a third tranche of surveys - either aerial counts or substantial additional socio-economic surveys. The choice between these alternatives would depend largely upon the results obtained during the preceding aerial and ground work. The

objectives would be determined by whether or not the initial surveys confirmed the Government data on productivity, distributions and numbers.

86. As well as continuing the investigations started in the initial surveys, additional ground work could be designed to complement the other livestock monitoring studies envisaged - specifically the health monitoring (see below), and to identify any changes in livestock marketing and management practices during the life of the proposed project that may be consequent upon economic developments. These would provide a detailed 'snapshot' of prevailing conditions, as opposed to the temporal information provided by the proposed herd monitoring.

87. Further aerial survey work could either complement the first two counts, by being conducted during the period when livestock are feeding on crop residues in June and July, or at the end of the Project's expected life, to enable an assessment of any medium term changes in range utilisation.

88. The latter option's major advantage would be in establishing changes in animal numbers during the Project's expected life. This, however is viewed as a secondary objective of the proposed studies. Firstly, the output from the verification of DoS data carried out during the April aerial survey could be used, if required, to validate DoS data collected in subsequent years. This allow the DoS data to be used to assess trends in animal numbers. Secondly, precise numbers are only needed to establish resource utilisation models, rather than population estimates *per se*. Thirdly, inter-annual variability in rainfall, and consequently in the productivity of the rangeland, may well invalidate any but the broadest comparison of animal numbers from two years.

89. A third survey in June or July, would, in contrast, provide valuable information about the utilisation of crop-residues by livestock. This is an important part of the management system in the proposed survey area, and would help establish the relative contributions of natural rangeland and cropping to the annual livestock feed budget. The Terms of Reference provided below relates to this option.

90. A survey of 70,000 square kilometres at 10km resolution costs almost exactly the same as one of 28,600 at a 4 km flight line spacing. A final alternative would therefore be to enlarge the proposed survey area to cover most of the country during the third survey, thus providing more data on rangeland utilisation in different vegetation categories, and population data for more Governorates. It is suggested that the choice between these options is made during the pre-implementation phase of the proposed Project, and should be based on the requirements of the Ministry and other collaborating institutions.

91. Training in survey methodology, design and execution would be provided to counterpart staff, so that a national capability would be established, for future use. Initially this would consist of limited on the job training for counterpart field staff. Towards the end of the proposed survey programme, a training course lasting two weeks would be run, detailing the steps involved in setting up and executing an aerial survey, processing the results and analysing the data obtained.

Cost and Timing

92. The Study would be carried out in Project Years One and Two. The estimated cost is US$ 600,000. Various breakdowns can be found in Annex 5.

Table A4.11: Estimated Cost of Livestock Distribution and Movement Study (US$1000's).

PY1	PY2	PY3	PY4	PY5	**Total**
400	200	0	0	0	**600**

B). GEO-REFERENCING EXISTING NATIONAL LIVESTOCK DATA

Objectives

93. Geo-referencing existing livestock data held by DoS.

Proposed Study

94. In order to make the DoS livestock data more compatible with, for example, vegetation data derived from satellite imagery, the existing records would have to be geo-referenced. Currently they are identified by village name, but the map co-ordinates are not known. It is therefore proposed to provide limited funding to the Livestock Statistics Section to acquire topographic maps upon which the location of each census point would be identified. Their latitude and longitude co-ordinates could then be extracted and added to the present data base. Short term technical assistance, either from PRIME or from the Royal Jordanian Geographic Centre, would be required to oversee the initial stages of this process, and to ensure that the data produced was in a format compatible with PRIME's central data bank.

95. The 1991 Livestock Census involved approximately 1,200 counting centres, whilst the bi-annual sample surveys include some 3,000 respondents. Thus a total of about 4,000 points would have to be identified and located. This can be very time consuming as it may be necessary to re-examine original data collection sheets to confirm location names, and these then have to be located on large scale maps, or via gazetteers. It is envisaged that this Study would, thus, require two to three months input from two DoS staff who would be seconded to the Project for that period. Funding provision has also been proposed to purchase a number of sets of hard copy and digitised maps from RJGC.

Cost and Timing

96. The study would be undertaken in Project Year One and is estimated to cost US$ 5,000.

C). DETAILED HERD MONITORING

Objectives and Rationale

97. Regular herd production and health monitoring requires the close collaboration of the herders and owners, both to obtain and confirm access to the animals being studied, to locate the herds, and to find out what has happened to the animals between monitoring visits. Such collaboration can only be achieved by careful explanation of aims and objectives, and sensitivity and responsiveness to herders' and owners' opinions and perceptions.

98. Herd monitoring, thus, allows for the investigation of animal parameters, and provides an opportunity to establish a dialogue and exchange information with the owners.

99. Though data are available at a national level, there is little concrete information that can be used to assess the relative importance of livestock to pastoralists in the more remote areas. Less is known about the decisions influencing animal marketing. These topics can only be investigated by establishing close contact with pastoralists on a regular basis.

100. Detailed data on the sub-clinical incidence of several small ruminant diseases are scarce. In particular, the potentially synergistic effects on production and fertility of infection by more than disease is postulated but not substantiated. These can only be investigated by continuous examination of a number of known animals.

101. Relatively few mechanisms exist in Jordan to assess pastoralist perceptions to innovation, possible interventions, or awareness of rangeland issues, on a regular basis.

102. The objectives of the proposed study are thus to:

- assess animal health - particularly the incidence of PPR, FMD and Blue Tongue and their effects on fertility and weight gain;
- assess marketing strategies;
- establish a dialogue with herd owners to promote awareness of rangeland issues and solicit their reactions to proposed interventions and policies. This would be used as a potential template for designing national awareness programmes directed specifically at pastoralists in remote areas.

Proposed Study

103. A study by BRDP and JCO is already in progress, which is carrying out detailed monitoring of animal health in 20 herds around the Safawi Field Centre. This programme has set up close links with the stock-owners, who are now co-operating fully with the study team.

104. Both current production characteristics and the effect of various interventions are being monitored, as well as aspects of health, management and nutrition. These include assessing disease incidence - at clinical and sub-clinical levels, measuring mortality levels, monitoring weight gain in all age classes, and collecting fertility and proflicacy data.

105. It is proposed to double the number of flocks that are currently monitored from 20 to 40-50 flocks, and to expand the existing informal socio-economic element to incorporate questionnaire based survey techniques thereby increasing the number, and formalising the structure, of questions being put to the pastoralists. The questions asked would be directed at two topics: marketing at the farmgate level, and the relative importance of livestock in the household economy.

106. The marketing information collected would include the reasons for animal sales in general, what determined the selection of the animals to sell, and to what extent the prices offered by traders for different categories of animal influenced the timing of sales or the type of animal sold.

107. Owners would also be asked to provide, confidentially, household economic information - including sources of income other than livestock so as to establish the relative contribution of livestock keeping in the family budget.

108. Regular meetings between study team staff and the stock owners would also be organised at which rangeland issues would be presented by PRIME personnel, and responses

to proposed solutions to rangeland degradation assessed. These gatherings would also be used to obtain the pastoralists' opinion on the most effective ways of presenting the information collected by PRIME's resource assessment activities.

109. It would be necessary to employ a Jordanian livestock specialist (preferably from the Badia area), and to employ local villagers/Bedu to facilitate farmer feedback and exchange of views with the Project staff. Short-term technical assistance would be required to supervise the field work. A full time field assistant would be required to follow more mobile pastoralists.

110. Eight village-based staff (possibly part-time) would also be needed. These would be locally employed villagers able to interact with the farmers. They would liaise with farmers, organise meetings in the field, inform programme staff of any feedback from farmers between visits, and meet farmers regularly for monitoring purposes.

111. A four wheel drive vehicle would be required throughout the proposed study, which would be provided from the PRIME pool.

Cost and Timing

112. The Study would be started in Project Year Two and continue for two years. The estimated total cost is US$ 50,000. Various breakdowns can be found in Annex 5.

Table A4.12: Estimated Cost of Detailed Herd Monitoring Study (US$1000's).

PY1	PY2	PY3	PY4	PY5	**Total**
0	25	25	0	0	**50**

D). ANIMAL HEALTH MONITORING, VETERINARY DEPARTMENT

Objectives

- To strengthen of animal health monitoring to permit the analysis of unprocessed data, and expand future monitoring and analysis capability to permit a special emphasis on the levels of sub-clinical expressed disease in small ruminant populations.

Proposed Study

113. It is proposed to enhance the processing and analysis capabilities of the existing Epidemiology and Production Monitoring Section of the Veterinary Department in order to improve the scope and throughput of animal health statistics, and to clear the backlog of unprocessed information. This would involve the provision of two additional data processing personnel and a qualified veterinarian with some experience in analysis and interpretation of epidemiological information.

114. The additional vet's responsibilities would also include enhancing the Department's capabilities for recognising and diagnosing the sub-clinical expression of the major diseases which are currently thought to be most debilitating to small ruminants - Foot and Mouth Disease, Peste des Petits Ruminants (PPR) and Blue Tongue.

115. This expertise would be used to establish, in Project Year 1, a monitoring system to investigate the true incidence of these diseases, both singly, and in any of the possible combinations. Such a system would become part of the Monitoring Division's normal flock

visiting activities. Close liaison should be sought with both the veterinary staff of JCO and the personnel executing the Detailed Herd Monitoring Study (see above), to ensure agreement between all parties as to the methods used.

116. In addition, the existing computer hardware would have to be upgraded to Pentium standards or better, and the latest version of the Panacea livestock monitoring software currently in use would be provided and installed. This would be accomplished in the early part of Project Year 1. Short-term technical assistance from the software designers would be required to integrate the present data base into the upgraded software, and to refine the currently available skills in analysis. In particular, the facility for geo-referencing new data would be incorporated into the data processing routines, and, if the requisite information exists in the Division's archives, locations should be appended to existing data. The output of the strengthened Division would be made available to PRIME's central data bank.

Cost and Timing

117. The Study would run for the full term of the proposed Project, starting in Project Year One. The estimated cost is US$ 101,000. Details can be found in Annex 5

Table A4.13: Estimated Cost of Animal Health Monitoring Study (US$1000's).

PY1	PY2	PY3	PY4	PY5	**Total**
33.3	16.9	16.9	16.9	16.9	**100.9**

E). INTENSIFICATION AND MARKETING

118. One of the proposed mechanisms for destocking the Jordanian rangelands is the removal of excess lambs produced each year for fattening at commercial feedlots. Given that feed supplementation and sheep fattening is common practice throughout much of the country, it is important to define and establish exactly what is meant by a commercial feedlot, and to devise an appropriate framework and methodology for monitoring changes anticipated for the future.

119. Should the Development Programme be implemented, this form of intensified livestock production clearly needs to be considered in the wider context of livestock trade and marketing, which includes both imports and exports, as well as animals in transit. Whilst the Ministry of Agriculture and Department of Statistics collect and publish some relevant trade and marketing data, these are considered to be inappropriate for monitoring detailed changes in the livestock production system. A special study is therefore proposed to provide a general review of livestock marketing in Jordan, examine the current status of commercialised feedlots and sheep fattening operations, and identify appropriate indicators for future monitoring.

Cost and Timing

120. The Study would be started if and when implementation of the Development Programme was confirmed. This is likely to be towards the end of the Proposed Project, perhaps in PY3 or PY4. It is envisaged that this Study be funded from the Further Studies line item in PRIME's budget. Preliminary estimates of total cost are in the region of US$ 50,000 .

TERMS OF REFERENCE FOR LIVESTOCK RELATED STUDIES

121. Outline TOR's for the proposed studies are set out below. It is emphasised that these are for illustrative purposes only. Where appropriate, details are included regarding the personnel to be recruited on a long term basis. Specifications for short-term technical assistance have not been provided.

A).GEO-REFERENCING OF EXISTING LIVESTOCK DATA

122. Livestock statistics currently available in DoS archives are not geo-referenced. In order to make them more compatible with satellite data, and to permit their analysis in relation to geographical parameters, such as rainfall, or agro-ecological zone, it is necessary to identify the locations of each Census counting centre or sample survey point, and match these to existing records. This will be undertaken in the context of the Pastoral Resource Assessment and Monitoring and Co-ordinating Project, through the Pastoral Resources Information, Monitoring and Evaluation Unit (PRIME).

Study Requirements

123. The requirements of the study are as follows:

- To locate each Census counting centre and sample survey point, to an accuracy of one kilometre or less, and identify their co-ordinates using either latitude and longitude or Jordan Transverse Mercator systems;
- To provide to PRIME a hard copy and digital listing of the co-ordinates together with identification details (such as village name or code) that can be used to link the locations to existing data files;
- To provide to PRIME matched location Census population data for sheep, goats, camels cattle, donkeys and horses for each Census counting centre and for the two most recent sample surveys.

124. The listing will be made available within three months of the study agreement being signed. It is understood that no confidential data, which might permit the identification of livestock owners or survey respondents, will be released to PRIME as part of this Study.

125. PRIME will consult with DoS regarding all analyses and interpretation of the data provided, and will supply hard copy and digital listings of such information as it becomes available.

126. Funding will be provided to purchase maps as required. Technical assistance will be provided from either RJGC or PRIME staff resources for the first month of the study, in order to familiarise DoS staff with the technical details, as required.

127. It is anticipated that DoS staff familiar with details of the Department's Livestock population estimates will undertake the study, who would be seconded to PRIME for the duration of the anticipated work. Should DoS staff be unavailable, PRIME will recruit suitable computer literate graduate personnel to work under DoS supervision. PRIME will pay all salaries, staff expenses and consumable costs incurred by DoS, upon delivery of the data required.

B). LIVESTOCK DISTRIBUTION, MOVEMENT AND MANAGEMENT

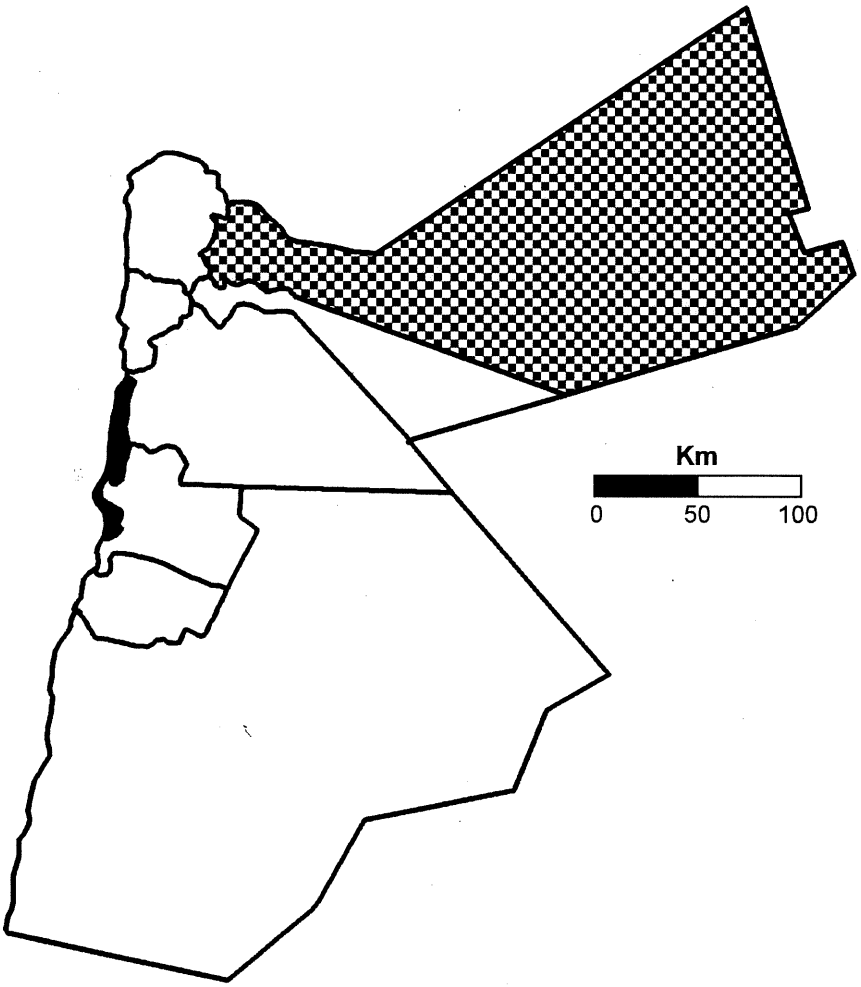
128. A series of integrated air-ground surveys of Mafraq Governorate are required to provide baseline numerical and distribution data concerning livestock, land use and human habitation. These will be undertaken in the context of the Pastoral Resource Assessment and Monitoring and Co-ordinating Project, through the Pastoral Resources Information, Monitoring and Evaluation Unit (PRIME).

Survey Requirements

129. The parameters to be assessed will include:

- a) Numbers and distribution of different livestock species, specifically sheep, goats, camels, and cattle;
- b) Location and extent of cultivated land;
- c) Approximate type and density of natural vegetation cover;
- d) Numbers, types and distribution of human habitation;
- e) Location surface water and water points;
- f) Patterns of livestock ownership and perceived constraints on production.

Figure A4.11: The Proposed Survey Area



130. The survey will cover Mafraq Province in the north-east of Jordan (Figure A4.12). The total land area to be surveyed is estimated to be in the order of 28,600 square kilometres. The sampling intensity proposed should ensure compatibility between NOAA satellite imagery and

the survey results. This is envisaged to require that results be produced for a lattice of 4x4km grids covering the whole Governorate.

131. It is envisaged that three surveys are necessary to establish seasonal differences in livestock numbers and distribution. These would be most appropriately carried out in February, April and July.

132. The methodology employed should be that of SRF (Systematic Reconnaissance Flights), alongside a complementary ground survey, or a related technique of proven merit. Any technique used should be capable of replication at a later date. Organisations tendering for this work are advised that they are required to demonstrate previous experience of aerial surveys and ground truthing, or an equivalent technique, involving both livestock and human populations, and natural vegetation cover, and to include curriculum vitae of the senior personnel who would undertake the study.

133. Subject to availability, the aircraft should be hired from a charter company registered in Jordan which should be equipped with a radar altimeter and a GPS navigation system. Should this be impractical, or should it prove more cost-effective, the contractor may import a suitably equipped aircraft into Jordan. GoJ will then assist in obtaining duty-free import clearances and operating clearances.

134. The ground-truthing should be carried out to be carried out, between February and April, by a consultant who would also be responsible for the co-ordination of groundwork and the orientation of the studies. The consultant should have experience in air/ground survey as well as some exposure to working conditions in dryland areas. The sociological work should have a qualitative element, assessing seasonal movement strategies and perceived constraints on livestock production. Proportions of sheep to goats in small ruminant herds and animals obscured from aerial observation in different village types should also be assessed, at sampling intensities consistent with the provision of statistically reliable information.

135. GoJ will be responsible for following up initial enquiries and obtaining security clearances for the proposed survey. Certain areas, such as the borders with Iraq and Saudi Arabia, may have to be excluded on security grounds. GoJ will inform the company as soon as any further information becomes available. GoJ undertakes to provide such clearances and information at least six weeks prior to the survey proposed starting date.

Training Elements

136. GoJ wishes to use the air/ground survey as an exercise to train its own staff in various aspects of this type of research. It therefore proposes to supply staff as follows;

- *Aerial survey observers.* Apart from the aerial survey co-ordinator, the contractor should supply two trained observers. The observers will then train two counterpart staff members, of graduate status or higher, either flying with them on alternate days, or using one on each of the seasonal surveys. If the counterpart staff members have adequate mathematical abilities, they may also be trained in additional data preparation.
- *Livestock enumerators.* GoJ will supply two counterpart enumerators, of graduate level or higher, to participate in the Ground Survey. A background in livestock projects is desirable, but the principal qualifications are Arabic language and some English numeracy.

137. The contractor will be given the opportunity to confirm the suitability of counterpart staff provided during trial survey sessions prior to the start of the surveys. Any considered to be unsuited to the survey work required will be replaced.

Analysis and Reporting

138. Data from the survey should be entered into a database with statistical and mapping capabilities. GoJ should be able to specify cartographic variables, such as district boundaries, project areas, roads etc. The database should permit the analysis of relationships between livestock and satellite derived vegetation estimates, and other features, such as water courses, roads, towns. GoJ agrees to specify such features and variables in advance of the data entry.

139. The final report should include:

- A review of previous material and selected bibliography;
- Maps of the province showing the distribution of livestock and other designated variables in for each survey;
- Tables giving relevant numerical data;
- Analysis of the significance of the findings and their relevance to GoJ's longer-term rangeland studies and development plans.

140. The preliminary aerial survey data should be made available to GoJ within one month of the completion of each survey. A brief interim report of the summarising the findings of the February and April survey, written in English, should be made available to GoJ before beginning the July survey, to give time for comment and criticism. This interim report should be available in at least three copies.

141. A final report, presenting the findings of all three surveys, should be presented to GoJ no later than four months after the completion of fieldwork. Deadlines may be extended subject to mutual agreement

142. The final report should be written in English and made available to GoJ in 25 copies, with further copies supplied at additional cost. GoJ will retain sole rights over the information collected and shall itself distribute the report, unless it gives the company a written waiver to the contrary.

143. The following shall also be supplied with the final report:

- One complete set of all colour slides taken during the survey, with a note of their date and grid cell.
- The complete computerised database, converted to an ASCII file, or other format specified by GoJ, together with a code list.

C). DETAILED HERD MONITORING

144. GoJ proposes to commission a detailed Herd Monitoring Study, based at the Safawi Field Centre, designed to assess animal health and production in relation to disease incidence. During the course of this Study, a number of socio-economic criteria will also be investigated. This work will be achieved in the context of the Pastoral Resource Assessment and Monitoring and Co-ordinating Project, through the Pastoral Resources Information, Monitoring and Evaluation Unit (PRIME).

Study Requirements

145. It is envisaged that the required objectives will be best achieved through an expansion of the herd monitoring programme already being undertaken by BRDP. This will allow the monitoring of an additional 20-30 flocks for a period of two years, taking the total number of flocks in the expanded programme to between 40 and 50.

146. The primary aims of the study will be to assess animal health - particularly the incidence of PPR, FMD and Blue Tongue and their effects on fertility and weight gain; to assess owners' marketing strategies, and the role that livestock production plays in the household economy; and to establish a dialogue with herd owners to promote awareness of rangeland issues and solicit their reactions to proposed interventions and policies. Feedback would be used to guide the design of a national awareness programme directed specifically at pastoralists in remote areas.

147. Funding will be provided to employ a full time local livestock specialist who will be responsible for the overall execution of the project. The appointee should have gained an M.Sc. or equivalent qualification, or better, and have at least 5 years field experience in the area of animal health or livestock production. Knowledge of both will be essential. A working familiarity with interview procedures and data recording will also be required.

148. The livestock specialist will be responsible for co-ordinating the activities of a team of nine field assistants, who will be involved in the monitoring process. This supervision will include establishing and implementing the monitoring schedule, and ensuring the satisfactory quality and consistency of the data obtained. The specialist will collate the information collected on a regular basis for provision to PRIME.

149. The specialist will discuss the Study programme with relevant personnel at JCO and the Ministry of Agriculture to ensure a consensus approach to diagnoses of animal diseases - particularly FMD, PPR and Blue Tongue.

150. The Study Team will be provided with a 4WD vehicle from PRIME's central pool as required. International Technical Assistance will also be provided for up to one month per year, in order to advise on the detailed design of the monitoring programme, and to identify the criteria to be monitored, and to specify details of the analyses required.

D). ANIMAL HEALTH MONITORING

151. GoJ intends to strengthen the available livestock health monitoring capabilities within the Veterinary Department at the Ministry of Agriculture, and to provide the capability to improve its diagnostic and monitoring capabilities regarding the sub-clinical incidence of selected livestock diseases. This process will be achieved in the context of the Pastoral Resource Assessment and Monitoring and Co-ordinating Project, through the Pastoral Resources Information, Monitoring and Evaluation Unit (PRIME).

Study Requirements

152. The existing backlog of un-processed data collected during the course of the normal monitoring activities of the Epidemiology and Production Monitoring Division will be cleared, and where possible geo-referenced. To facilitate this process the Division will be provided with two Pentium level personal computers, and the existing Panacea livestock monitoring software will be upgraded.

153. The existing data will be transferred to the a new database, set up using the upgraded software. Technical assistance from the software manufacturers may be supplied for a period of up to a month from PRIME resources, if required.

154. In order to achieve this work, the funding needed to employ two additional data processors will be provided to the Division. These personnel will selected by the Division, and must have had at least 2 years experience of computer data entry and processing. Some prior exposure to work relating to livestock would be desirable.

155. The Division will also be supplied with the resources to employ an additional qualified veterinarian to assist with the expanded monitoring capabilities. The Division will ensure that the person selected will have been qualified for at least 5 years, will have an adequate knowledge of small ruminant diseases, and will be familiar with monitoring techniques.

156. The primary task of this new staff member will be to set up a monitoring system designed to established the incidence and distribution of PPR, FMD and Blue Tongue thought to be widely expressed at sub-clinical levels within Jordan's small ruminant population. Particular emphasis should be paid to the concurrence of two or more of these diseases. This monitoring effort should run alongside the Division's normal monitoring activities. The geographical coverage of this monitoring study will be designed to provide both a national and a regional perspective.

157. This work will be carried out in close collaboration with other institutions conducting animal health studies in Jordan. These are likely to include the Jordan Co-operative Organisation, and the Badia Research and Development Programme based at the Safawi Field Centre. The Division will ensure that the monitoring programme set up is compatible with such studies, and that a consensus of agreement is reached as to the symptoms or other indicators assessed.

158. All data collected during the term of the Study should be geo-referenced to within one kilometre, either by latitude and longitude or the Jordanian Transverse Mercator co-ordinates. These data will be provided in digital form to PRIME every six months, in a format compatible with PRIME analytical capabilities.

159. The funding for additional staff will initially be provided for a period of one year. Subsequent funding will be conditional upon satisfactory progress, as demonstrated by the provision of adequate data to PRIME within this initial period, and will be subject to PRIME's approval on an annual basis.

E). INTENSIFICATION AND MARKETING

Objectives

160. To assess the current status of commercialised feedlots and semi-intensive sheep fattening operations; identify appropriate indicators for future monitoring; and provide a general review of livestock marketing in Jordan.

Proposed Study

161. One of the proposed mechanisms for destocking the Jordanian rangelands is the removal of excess lambs produced each year from the rangelands, for fattening at commercial feedlots.

162. Given that feed supplementation and sheep fattening is common practice throughout much of the country, it is obviously important to define and establish exactly what is meant by a commercial feedlot, and to devise an appropriate framework and methodology for monitoring changes anticipated for the future.

163. This form of intensified livestock production clearly needs to be considered in the wider context of livestock trade and marketing, which includes both imports and exports, as well as animals in transit. Whilst the Ministry of Agriculture and Department of Statistics collect and publish some relevant trade and marketing data, these are considered to be inappropriate for monitoring detailed changes in the livestock production system.

164. A special study is therefore required to examine the current status of commercialised feedlots and sheep fattening operations, identify appropriate indicators for future monitoring, and provide a general review of livestock marketing in Jordan

165. It is envisaged that investigations would be undertaken as an independent short-term consultancy, involving the collaborative inputs of a livestock production specialist and a livestock economist, and the supervision of a programme of postgraduate field research.

166. The study will build on the findings of IFAD's earlier baseline survey of socio-economic and economic production data (Blench, 1995) and the work of Bernhard Nörr (1995). It will review the range and process of livestock intensification in Jordan today; and characterise various stage/levels of intensity in small ruminant production (e.g. in terms of inputs supplied, management, use of improved genetic stock, outputs produced etc.), with a view to identifying appropriate monitoring parameters for the future.

TABLE OF CONTENTS

LIST OF DETAILED COST TABLES

A. INTRODUCTION

1. The proposed project relates to the establishment of an assessment, monitoring and co-ordinating facility, in order to provide planners with the necessary data to enable focused development plans to be drawn up to address the rehabilitation and development of the Jordanian Rangelands. There are therefore no immediate quantifiable economic benefits generated by this proposed project, the benefits will only accrue when the National Programme for Range Rehabilitation and Development is implemented. This analysis has therefore been limited to that of solely a financial one.

B. GENERAL ASSUMPTIONS

PRICES

2. Prices used in the cost estimates are based on those as at July 1995. Physical contingencies of 5% have been applied to all costs with the exception of technical assistance and local salaries where no physical contingencies have been included. Price contingencies are calculated on base costs plus physical contingencies and are compounded annually.

3. International inflation is expected to increase at an annual rate of 3.9% from 1992 through 1994 and thereafter at a rate of 3.8%. The projected rates of local inflation used for the calculation of the domestic price component of price contingencies assumes that the Government will obtain financing to implement adjustment programmes centred upon a reduction of the budget deficit. Under adjustment, the economy is expected to grow at 3% a year in 1995 and then at 4.5% by the end of the century while the current account deficit is reduced in an overall improvement of the balance of payments.

4. It has been assumed that about six months would lapse between appraisal and loan negotiations and that a further six months would be required for administrative processing by IFAD and other financiers. Implementation should therefore begin around September 1996. Taking into account changes in annual inflation over the course of a project year, the series of annual implementation inflation rates used are as follows:

Table A5.1: Series of Annual Implementation Rates

		PY1	PY2	PY3	PY4	PY5
Foreign	3.8	3.8	3.8	3.8	3.8	
Local		3.0	3.5	4.0	4.0	4.0

5. Implementation Exchange Rates in Constant Terms. The series of foreign and domestic inflation rates listed above generate the following set of constant purchasing parity exchange rates over the implementation period of the project:

Table A5.2: Constant Purchasing Parity Exchange Rates

PY1	PY2	PY3	PY4	PY5
0.6982	0.6966	0.6983	0.7017	0.7051

6. 6. It was assumed that the Government may wish to adjust the nominal exchange rate slowly in line with the set of constant purchasing parity values to dampen real increases in the costs of imported foods and important inputs.

DETAILED COST TABLES

7. The following pages present the Detailed Cost Tables prepared.

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.3: - Pastoral Resources, Information, Monitoring and Evaluation Unit Detailed Cost Table

Run Date: 18-Aug-95

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost JD'000	JD'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Vehicles															
	Saloon (HOU, Envir Spec & Infor Spec)		Each	3					3	13.9	41.8	0.0	0.0	0.0	0.0	41.8
	4WD Double cab Pickup(Studies/Field S'vision)		Each	4					4	17.4	69.6	0.0	0.0	0.0	0.0	69.6
	Sub-total	PVEQ		7	0	0	0	0	7		111.4	0.0	0.0	0.0	0.0	111.4
B.	Office Furniture & Equipment															
	Prime Unit Office		Lump	1					1	9.7	9.7	0.0	0.0	0.0	0.0	9.7
	GPS Units		Each	10					10	0.7	7.0	0.0	0.0	0.0	0.0	7.0
	Computers		Lump	1					1	105.8	105.8	0.0	0.0	0.0	0.0	105.8
	ArcInfo		Lump	1					1	41.8	41.8	0.0	0.0	0.0	0.0	41.8
	Sub-total	PVEQ									164.3	0.0	0.0	0.0	0.0	164.3
C.	Technical Assistance															
	Environmental Specialist		Man mth	12	12	12			36	8.7	104.4	104.4	104.4	0.0	0.0	313.2
	Information/Image Processing Specialist		Man mth	12	12	12			36	8.7	104.4	104.4	104.4	0.0	0.0	313.2
	Environment Economist		Man mth	2	2	2			6	10.4	20.9	20.9	20.9	0.0	0.0	62.6
	Sub-total	TASS		26	26	26	0		78		229.7	229.7	229.7	0.0	0.0	689.0
D.	Training															
	IT, GIS & Remote sensing Training		Man mth	10	10	10	0	0	30	3.5	34.8	34.8	34.8	0.0	0.0	104.4
	Extrnl Trainer re Data Analysis & Interpretation		Man mth	3	3	3	3	3	15	10.4	31.3	31.3	31.3	31.3	31.3	156.6
	Sub-total	TRN									66.1	66.1	66.1	31.3	31.3	261.0
E.	Awareness Programmes															
	Workshops		Lump	0.2	0.3	0.3	0.1	0.1	1	34.8	7.0	10.4	10.4	3.5	3.5	34.8
	Participatery Surveys		Lump	0.3	0.3	0.2	0.1	0.1	1	52.2	15.7	15.7	10.4	5.2	5.2	52.2
	Seminars		Lump	0.2	0.3	0.3	0.1	0.1	1	41.8	8.4	12.5	12.5	4.2	4.2	41.8
	Radio & TV Programmes		Lump	0.2	0.2	0.2	0.2	0.2	1	34.8	7.0	7.0	7.0	7.0	7.0	34.8
	Newsletter/Press Releases		Lump	0.2	0.2	0.2	0.2	0.2	1	17.4	3.5	3.5	3.5	3.5	3.5	17.4
	Audio Visual programmes		Each	1	1	1			3	34.8	34.8	34.8	34.8	0.0	0.0	104.4
	Sub-total	AWP									76.2	83.9	78.6	23.3	23.3	285.4
F.	Studies								0							
	Further Studies as identified		Lump			1	1	1	3	38.3	0.0	0.0	38.3	38.3	38.3	114.8
	Sub-total	CONSL									0.0	0.0	38.3	38.3	38.3	114.8
	Total Component Investment Costs										647.6	379.7	412.7	92.9	92.9	1625.9
II	Recurrent Costs:-															
	Incremental Salaries:-															
	Head of Unit/Project Manager-Phd		Man Yr	1	1	1	1	1	5	9.7	9.7	9.7	9.7	9.7	9.7	48.4
	Socio-economist - MSc		Man Yr	1	1	1	1	1	5	6.1	6.1	6.1	6.1	6.1	6.1	30.3
	Senior Monitoring & Eval Officer-MSc		Man Yr	1	1	1	1	1	5	6.7	6.7	6.7	6.7	6.7	6.7	33.3
	Range Management Officer-MSC		Man Yr	1	1	1	1	1	5	6.7	6.7	6.7	6.7	6.7	6.7	33.3
	Monitoring & Evaluation Officer-BSc		Man Yr	2	2	2	2	2	10	3.6	7.3	7.3	7.3	7.3	7.3	36.3
	Data Entry Computer operators-Dip		Man Yr	4	4	4	4	4	20	2.5	10.2	10.2	10.2	10.2	10.2	50.9
	Secretary		Man Yr	1	1	1	1	1	5	2.2	2.2	2.2	2.2	2.2	2.2	10.9
	Drivers		Man Yr	7	7	7	7	7	35	1.8	12.7	12.7	12.7	12.7	12.7	63.6
	Sub-total	LOS									61.4	61.4	61.4	61.4	61.4	307.0
	Field Allowances		Man Day	468	468	468	468	468	2340	0.02	9.4	9.4	9.4	9.4	9.4	47.2
	Vehicle Operating		Each	7	7	7	7	7		4.2	29.2	29.2	29.2	29.2	29.2	146.2
	R&M Equipment		%		10%	10%	10%	10%			0.0	12.2	12.2	12.2	12.2	49.0
	Computer consumables		Year	1	1	1	1	1	5	13.9	13.9	13.9	13.9	13.9	13.9	69.6
	House Rents		Year	2	2	2			6	10.0	20.0	20.0	20.0	0.0	0.0	60.1
	General Operating	GOP	Year	1	1	1	1	1	5	7.0	7.0	7.0	7.0	7.0	7.0	34.8
	Total Component Recurrent Costs										141.0	153.3	153.3	133.2	133.2	713.9
	Total Component Costs										788.6	532.9	566.0	226.1	226.1	2339.8

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.4: - Pastoral Resources, Information, Monitoring and Evaluation Unit
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost US$'000	US$'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Vehicles															
	Saloon (HOU, Envir Spec & Infor Spec)		Each	3					3	20.0	60.0	0.0	0.0	0.0	0.0	60.0
	4WD Double cab Pickup(Studies/Field Supervision)		Each	4				0	4	25.0	100.0	0.0	0.0	0.0	0.0	100.0
	Sub-total	PVEQ		7	0	0	0	0	7		160.0	0.0	0.0	0.0	0.0	160.0
B.	Office Furniture & Equipment															
	Prime Unit Office		Lump	1					1	14.0	14.0	0.0	0.0	0.0	0.0	14.0
	GPS Units		Each	10					10	1.0	10.0	0.0	0.0	0.0	0.0	10.0
	Computers		Lump	1					1	152.0	152.0	0.0	0.0	0.0	0.0	152.0
	ArcInfo		Lump	1					1	60.0	60.0	0.0	0.0	0.0	0.0	60.0
	Sub-total	PVEQ									236.0	0.0	0.0	0.0	0.0	236.0
C.	Technical Assistance															
	Environmental Specialist		Man mth	12	12	12			36	12.5	150.0	150.0	150.0	0.0	0.0	450.0
	Information/Image Processing Specialist		Man mth	12	12	12			36	12.5	150.0	150.0	150.0	0.0	0.0	450.0
	Environment Economist		Man mth	2	2	2			6	15.0	30.0	30.0	30.0	0.0	0.0	90.0
	Sub-total	TASS		26	26	26	0		78		330.0	330.0	330.0	0.0	0.0	990.0
D.	Training															
	IT, GIS & Remote sensing Training		man mth	10	10	10	0	0	30	5.0	50.0	50.0	50.0	0.0	0.0	150.0
	Extrnl Trainer re Data Analysis & Interpretation		man mth	3	3	3	3	3	15	15.0	45.0	45.0	45.0	45.0	45.0	225.0
	Sub-total	TRN									95.0	95.0	95.0	45.0	45.0	375.0
E.	Awareness Programmes															
	Workshops		Lump	0.2	0.3	0.3	0.1	0.1	1	50.0	10.0	15.0	15.0	5.0	5.0	50.0
	Participatery Surveys		Lump	0.3	0.3	0.2	0.1	0.1	1	75.0	22.5	22.5	15.0	7.5	7.5	75.0
	Seminars		Lump	0.2	0.3	0.3	0.1	0.1	1	60.0	12.0	18.0	18.0	6.0	6.0	60.0
	Radio & TV Programmes		Lump	0.2	0.2	0.2	0.2	0.2	1	50.0	10.0	10.0	10.0	10.0	10.0	50.0
	Newsletter/Press Releases		Lump	0.2	0.2	0.2	0.2	0.2	1	25.0	5.0	5.0	5.0	5.0	5.0	25.0
	Audio Visual programmes		Each	1	1	1			3	50.0	50.0	50.0	50.0	0.0	0.0	150.0
	Sub-total	AWP									109.5	120.5	113.0	33.5	33.5	410.0
F.	Studies								0							
	Further Studies as identified		Lump		0	1	1	1	3	55.0	0.0	0.0	55.0	55.0	55.0	165.0
	Sub-total	CONSL									0.0	0.0	55.0	55.0	55.0	165.0
	Total Component Investment Costs										930.5	545.5	593.0	133.5	133.5	2336.0
II	Recurrent Costs:-															
	Incremental Salaries:-															
	Head of Unit/Project Manager-Phd		Man Yr	1	1	1	1	1	5	13.9	13.9	13.9	13.9	13.9	13.9	69.6
	Socio-economist - MSc		Man Yr	1	1	1	1	1	5	8.7	8.7	8.7	8.7	8.7	8.7	43.5
	Senior Monitoring & Eval Officer-MSc		Man Yr	1	1	1	1	1	5	9.6	9.6	9.6	9.6	9.6	9.6	47.9
	Range Management Officer-MSC		Man Yr	1	1	1	1	1	5	9.6	9.6	9.6	9.6	9.6	9.6	47.9
	Monitoring & Evaluation Officer-BSc		Man Yr	2	2	2	2	2	10	5.2	10.4	10.4	10.4	10.4	10.4	52.2
	Data Entry Computer operators-Dip		Man Yr	4	4	4	4	4	20	3.7	14.6	14.6	14.6	14.6	14.6	73.1
	Secretary		Man Yr	1	1	1	1	1	5	3.1	3.1	3.1	3.1	3.1	3.1	15.7
	Drivers		Man Yr	7	7	7	7	7	35	2.6	18.3	18.3	18.3	18.3	18.3	91.4
	Sub-total	LOS									88.2	88.2	88.2	88.2	88.2	441.1
	Field Allowances		Man Day	468	468	468	468	468	2340	0.03	13.6	13.6	13.6	13.6	13.6	67.9
	Vehicle Operating		Each	7	7	7	7	7		6.0	42.0	42.0	42.0	42.0	42.0	210.0
	R&M Equipment		%		10%	10%	10%	10%			0.0	17.6	17.6	17.6	17.6	70.4
	Computer consumables		Year	1	1	1	1	1	5	20.0	20.0	20.0	20.0	20.0	20.0	100.0
	House Rents		Year	2	2	2			6	14.4	28.8	28.8	28.8	0.0	0.0	86.4
	General Operating	GOP	Year	1	1	1	1	1	5	10.0	10.0	10.0	10.0	10.0	10.0	50.0
	Total Component Recurrent Costs										202.6	220.2	220.2	191.4	191.4	1025.8
	Total Component Costs										1133.1	765.7	813.2	324.9	324.9	3361.8

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.5: - Range Assessment and Monitoring
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost JD'000	JD'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Furniture & Equipment															
	Computers - Range Division		Each	2					2	3.5	7.0	0.0	0.0	0.0	0.0	7.0
	Rangeland suitability maps		Lump	1					1	2.1	2.1	0.0	0.0	0.0	0.0	2.1
	Sub-total	PVEQ				0	0	0			9.0	0.0	0.0	0.0	0.0	9.0
B.	Technical Assistance															
	Range Management & Monitoring Spec		Man mth	3	1		1		9	10.4	31.3	10.4	0.0	10.4	0.0	52.2
	Remote Sensing (rainfall) Specialist		Man mth	7					3	10.4	73.1	0.0	0.0	0.0	0.0	73.1
	Sub-total	TASS									104.4	10.4	0.0	10.4	0.0	125.3
C.	Training															
	Range Mangt-Curriculum Devlmt-UoJ/NCARTT		Lump	1					1	17.4	17.4	0.0	0.0	0.0	0.0	17.4
	Range Mangt - Local training		man mth		80	80	80	80	320	0.16	0.0	12.9	12.9	12.9	12.9	51.7
	Range management-Overseas training		man mth		4	4	4		12	3.5	0.0	13.9	13.9	13.9	0.0	41.8
	Sub-total	TRN									17.4	26.8	26.8	26.8	12.9	110.8
D.	Studies															
	Ground Truthing-Landsat & NOAA Images (Polygon mapping)									Lump	35.5	13.5	13.5	13.5	13.5	89.5
	Ground Truthing of Meteosat Images									Lump	2.5	1.3	1.3	1.3	1.3	7.6
	Assessment of Trends in vegtn cover									Lump	19.8					19.8
	Monitoring of Rangeland vegtn cover-NOAA									Lump	0.5	0.5	0.5	0.5	0.5	2.5
	Monitoring of Rangeland vegtn species composition and biomass by ground based survey									Lump	5.8	2.9	2.9	2.9	2.9	17.4
	Develop & refine models of forage biomass production related to rainfall/soil moisture									Lump		2.8	0.3	0.3	0.3	3.7
	Pilot Regulated Grazing Experiments									Lump				15.3	5.2	20.5
	Sub-total	CONSL									64.1	20.9	18.5	33.7	23.7	160.9
	Total Component Investment Costs										195.0	58.2	45.3	71.0	36.6	406.1

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.6: - Range Assessment and Monitoring
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost US$'000	US$'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Furniture & Equipment															
	Computers - Range Division		Each	2					2	5.0	10.0	0.0	0.0	0.0	0.0	10.0
	Rangeland suitability maps		Lump	1					1	3.0	3.0	0.0	0.0	0.0	0.0	3.0
	Sub-total	PVEQ				0	0	0			13.0	0.0	0.0	0.0	0.0	13.0
B.	Technical Assistance															
	Range Management & Monitoring Spec		Man mth	3	1		1		9	15.0	45.0	15.0	0.0	15.0	0.0	75.0
	Remote Sensing Specialist		Man mth	7					3	15.0	105.0	0.0	0.0	0.0	0.0	105.0
									0							
	Sub-total	TASS									150.0	15.0	0.0	15.0	0.0	180.0
C.	Training															
	Range Mangt-Curriculum Devlmt-UoJ/NCARTT		Lump	1					1	25.0	25.0	0.0	0.0	0.0	0.0	25.0
	Range Mangt - Local training		man mth		80	80	80	80	320	0.23	0.0	18.6	18.6	18.6	18.6	74.2
	Range management-Overseas training		man mth		4	4	4		12	5.0	0.0	20.0	20.0	20.0	0.0	60.0
	Sub-total	TRN									25.0	38.6	38.6	38.6	18.6	159.2
D.	Studies															
	Ground Truthing-Landsat & NOAA Images (Polygon mapping)									Lump	51.0	19.4	19.4	19.4	19.4	128.5
	Ground Truthing of Meteosat Images									Lump	3.6	1.8	1.8	1.8	1.8	10.9
	Assessment of Trends in vegtn cover									Lump	28.5					28.5
	Monitoring of Rangeland vegtn cover-NOAA									Lump	0.7	0.7	0.7	0.7	0.7	3.6
	Monitoring of Rangeland vegtn species composition and biomass by ground based survey									Lump	8.3	4.2	4.2	4.2	4.2	24.9
	Develop & refine models of forage biomass production related to rainfall/soil moisture									Lump		4.0	0.4	0.4	0.4	5.3
	Pilot Regulated Grazing Experiments									Lump				21.9	7.5	29.5
	Sub-total	CONSL									92.2	30.0	26.5	48.4	34.0	231.2
	Total Component Investment Costs										280.2	83.6	65.1	102.0	52.6	583.5

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.7: - Soils & Land Use Evaluation and Mapping
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost JD'000	JD'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Equipment															
	Computer 586		Each	1			0.0	0.0	1	3.5	3.5	0.0	0.0	0.0	0.0	3.5
	Upgrade SPANS GIS		Each	1		0.0	0.0	0.0	1	1.7	1.7	0.0	0.0	0.0	0.0	1.7
	Support contract on SPANS		Each	1	1	1	1	1	5	1.1	1.1	1.1	1.1	1.1	1.1	5.6
	Sub-total	PVEQ									6.3	1.1	1.1	1.1	1.1	10.8
B.	Technical Assistance															
	Soil/Land Use Specialist		Man mth	3	0	0	0	0	3	10.4	31.3	0.0	0.0	0.0	0.0	31.3
	Soil/Water Specialist		Man mth		2	2	2	0	6	10.4	0.0	20.9	20.9	20.9	0.0	62.6
	Land Use Specialist		Man mth		1	0	0	0	1	10.4	0.0	10.4	0.0	0.0	0.0	10.4
	Soil Information/GIS Specialist		Man mth	1	1	1	1	0.0	4	10.4	10.4	10.4	10.4	10.4	0.0	41.8
	Sub-total	TASS									41.8	41.8	31.3	31.3	0.0	146.2
C.	Training															
	Remote Sensing/GIS		Man mth		6	3	0	0.0	9	3.5	0.0	20.9	10.4	0.0	0.0	31.3
	MSc training grant		Lump		1	0	0	0.0	1	3.5	0.0	3.5	0.0	0.0	0.0	3.5
	Computer Programming training		Lump		1	0	0	0.0	1	1.5	0.0	1.5	0.0	0.0	0.0	1.5
	GIS technician		Man mth	3	0	0	0	0.0	3	3.5	10.4	0.0	0.0	0.0	0.0	10.4
	Soils & Water training		Man mth		6	3	0	0.0	9	3.5	0.0	20.9	10.4	0.0	0.0	31.3
	Water Balance Training		Man mth		3				3	3.5	0.0	10.4	0.0	0.0	0.0	10.4
	Sub-total	TRN									10.4	57.2	20.9	0.0	0.0	88.5
D.	Studies															
	Land Suitability for Rangeland Improvement									Lump	47.7	11.8	11.8	11.8	11.8	95.1
	Water Balance Study									Lump		6.7	3.8	3.8	3.8	18.0
	Interaction of Cropland and Rangeland									Lump		1.0	1.0	1.0		3.0
	Sub-total	CONSL									47.7	19.5	16.6	16.6	15.6	116.1
	Total Component Investment Costs										106.3	119.6	69.9	49.1	16.7	361.6

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.8:- Soils & Land Use Evaluation and Mapping
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost US$'000	US$'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Equipment															
	Computer 586		Each	1			0.0	0.0	1	5.0	5.0	0.0	0.0	0.0	0.0	5.0
	Upgrade SPANS GIS		Each	1		0.0	0.0	0.0	1	2.5	2.5	0.0	0.0	0.0	0.0	2.5
	Support contract on SPANS		Each	1	1	1	1	1	5	1.6	1.6	1.6	1.6	1.6	1.6	8.0
	Sub-total	PVEQ									9.1	1.6	1.6	1.6	1.6	15.5
B.	Technical Assistance															
	Soil/Land Use Specialist		Man mth	3	0	0	0	0	3	15.0	45.0	0.0	0.0	0.0	0.0	45.0
	Soil/Water Specialist		Man mth		2	2	2		6	15.0	0.0	30.0	30.0	30.0	0.0	90.0
	Land Use Specialist		Man mth		1	0	0	0	1	15.0	0.0	15.0	0.0	0.0	0.0	15.0
	Soil Information/GIS Specialist		Man mth	1	1	1	1	0.0	4	15.0	15.0	15.0	15.0	15.0	0.0	60.0
	Sub-total	TASS									60.0	60.0	45.0	45.0	0.0	210.0
C.	Training															
	Remote Sensing/GIS		Man mth		6	3	0	0.0	9	5.0	0.0	30.0	15.0	0.0	0.0	45.0
	MSc training grant		Lump		1	0	0	0.0	1	5.0	0.0	5.0	0.0	0.0	0.0	5.0
	Computer Programming training		Lump		1	0	0	0.0	1	2.2	0.0	2.2	0.0	0.0	0.0	2.2
	GIS technician		Man mth	3	0	0	0	0.0	3	5.0	15.0	0.0	0.0	0.0	0.0	15.0
	Soils & Water training		Man mth		6	3	0	0.0	9	5.0	0.0	30.0	15.0	0.0	0.0	45.0
	Water Balance Training		Man mth		3				3	5.0	0.0	15.0	0.0	0.0	0.0	15.0
	Sub-total	TRN									15.0	82.2	30.0	0.0	0.0	127.2
D.	Studies															
	Land Suitability for Rangeland Improvement									Lump	68.6	17.0	17.0	17.0	17.0	136.6
	Water Balance Study									Lump		9.6	5.4	5.4	5.4	25.9
	Interaction of Cropland and Rangeland									Lump		1.4	1.4	1.4		4.3
	Sub-total	CONSL									68.6	28.0	23.9	23.9	22.5	166.8
	Total Component Investment Costs										152.7	171.8	100.5	70.5	24.1	519.5

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.9: - Livestock Related Studies
Detailed Cost Table

			Unit	Quantity						JD'000 Base Costs					
				PY1	PY2	PY3	PY4	PY5	Total	Unit Cost JD '000	PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
	Studies															
	Livestock Distribution & Movement Study		Lump	2	1				3	139.2	278.4	139.2	0.0	0.0	0.0	417.6
	Livestock Herd Monitoring		Lump		1				1	34.8	0.0	34.8	0.0	0.0	0.0	34.8
	Geo-referencing Natl Livestock Statistics		Lump	1					1	3.5	3.5	0.0	0.0	0.0	0.0	3.5
	Total Component Investment Costs		CONSL								281.9	174.0	0.0	0.0	0.0	455.9

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.10: - Livestock Related Studies
Detailed Cost Table

	SA	Unit	Quantity PY1	Quantity PY2	Quantity PY3	Quantity PY4	Quantity PY5	Total	Unit Cost US$'000	Base Costs US$'000 PY1	PY2	PY3	PY4	PY5	Total
I Investment Costs:-															
Studies															
Livestock Distribution & Movement Study		Lump	2	1				3	200.0	400.0	200.0	0.0	0.0	0.0	600.0
Livestock Herd Monitoring		Lump		1				1	50.0	0.0	50.0	0.0	0.0	0.0	50.0
Geo-referencing Natl Livestock Statistics		Lump	1					1	5.0	5.0	0.0	0.0	0.0	0.0	5.0
Total Component Investment Costs		CONSL								405.0	250.0	0.0	0.0	0.0	655.0

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.11: - Institutional Support and Collaboration
Detailed Cost Table

			Unit	Quantity PY1	PY2	PY3	PY4	PY5	Total	Unit Cost JD '000	JD'000 Base Costs PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Furniture & Equipment															
	Dept of Meteorology:-															
	Satellite Equipment		Each	1					1	7.0	7.0	0.0	0.0	0.0	0.0	7.0
	Computers & Optical disc drives		Each	2					2	6.3	12.7	0.0	0.0	0.0	0.0	12.7
	Royal Jordanian Geographical Centre:-										0.0	0.0	0.0	0.0	0.0	0.0
	Workstations & Optical Disk Drives		Each	1					1	5.6	5.6	0.0	0.0	0.0	0.0	5.6
	Veterinary Department:-										0.0	0.0	0.0	0.0	0.0	0.0
	Computer incl software		Each	2					2	5.7	11.4	0.0	0.0	0.0	0.0	11.4
	Ministry of Water & Irrigation:-										0.0	0.0	0.0	0.0	0.0	0.0
	Equipment Support		Lump	1					1	3.5	3.5	0.0	0.0	0.0	0.0	3.5
											0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total	PVEQ									40.1	0.0	0.0	0.0	0.0	40.1
B.	Training															
	Training - Overseas		Man mth	2	2	2	0		6	3.5	7.0	7.0	7.0	0.0	0.0	20.9
									0		0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total	TRN									7.0	7.0	7.0	0.0	0.0	20.9
	Total Component Investment Costs										47.0	7.0	7.0	0.0	0.0	61.0
II	Recurrent Costs:-															
	Incremental Salaries:-															
	Meterologist/computer data analyst		man yr	1	1	1	1	1	5	6.7	6.7	6.7	6.7	6.7	6.7	33.3
	Veterinarian		man yr	1	1	1	1	1	5	6.7	6.7	6.7	6.7	6.7	6.7	33.3
	Data entry operators(vet div)		man yr	2	2	2	2	2	10	2.5	5.1	5.1	5.1	5.1	5.1	25.4
	Total Component Recurrent Costs		LOS								18.4	18.4	18.4	18.4	18.4	92.0
	Total Component Costs										65.5	25.4	25.4	18.4	18.4	153.0

The Hashemite Kingdom of Jordan
National Range Rehabilitation and Development Programme
Pastoral Resources Assessment, Monitoring and Co-ordinating Project

Table A5.12: - Institutional Support and Collaboration
Detailed Cost Table

			Unit	Quantity							US$'000 Base Costs					
				PY1	PY2	PY3	PY4	PY5	Total	Unit Cost US$'000	PY1	PY2	PY3	PY4	PY5	Total
I	Investment Costs:-	SA														
A.	Office Furniture & Equipment															
	Dept of Meteorology:-															
	Satellite Equipment		Each	1					1	10.0	10.0	0.0	0.0	0.0	0.0	10.0
	Computers & Optical disc drives c/w discs		Each	2					2	9.1	18.2	0.0	0.0	0.0	0.0	18.2
	Royal Jordanian Geographical Centre:-										0.0	0.0	0.0	0.0	0.0	0.0
	Workstations & Optical Disk Drives		Lump	1					1	8.0	8.0	0.0	0.0	0.0	0.0	8.0
	Veterinary Department:-										0.0	0.0	0.0	0.0	0.0	0.0
	Computer incl software		Lump	2					2	8.2	16.4	0.0	0.0	0.0	0.0	16.4
	Ministry of Water & Irrigation:-										0.0	0.0	0.0	0.0	0.0	0.0
	Equipment Support		Lump	1					1	5.0	5.0	0.0	0.0	0.0	0.0	5.0
											0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total	PVEQ									57.6	0.0	0.0	0.0	0.0	57.6
B.	Training															
	Training - overseas		Man mth	2	2	2	0		6	5.0	10.0	10.0	10.0	0.0	0.0	30.0
									0		0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total	TRN									10.0	10.0	10.0	0.0	0.0	30.0
	Total Component Investment Costs										67.6	10.0	10.0	0.0	0.0	87.6
II	Recurrent Costs:-															
	Incremental Salaries:-															
	Meterologist/computer data analyst		man yr	1	1	1	1	1	5	9.6	9.6	9.6	9.6	9.6	9.6	47.9
	Veterinarian		man yr	1	1	1	1	1	5	9.6	9.6	9.6	9.6	9.6	9.6	47.9
	Data entry operators(vet div)		man yr	2	2	2	2	2	10	3.7	7.3	7.3	7.3	7.3	7.3	36.5
	Total Component Recurrent Costs		LOS								26.4	26.4	26.4	26.4	26.4	132.2
	Total Component Costs										94.0	36.4	36.4	26.4	26.4	219.8

Table A5.13: Office Furniture & Equipment

Schedule of Items - PRIME

Item No.	Description	Cost JD	Qty	Value JD
1	Office desk - Large, Senior staff	146.00	8	1,168.00
2	Office chair - Large, Senior staff	50.00	8	400.00
3	Office desk - General	77.00	4	308.00
4	Office chair - General	32.00	4	128.00
5	Visitors chair	20.00	24	480.00
6	Typist desk	90.00	1	90.00
7	Typist chair	35.00	1	35.00
8	Filing cabinet - 4 drawer type	104.00	14	1,456.00
9	Electric Typewriter	600.00	1	600.00
10	Photocopier - medium size	2000.00	1	2,000.00
11	Photocopier - large size	2400.00	1	2,400.00
12	Fax machine	700.00	1	700.00
			JD	9,765.00
			US$	14,030.17

Table A5.14: Local Salaries - PRIME

Staff Position and Qualification	Monthly Salary JD
Project Manager - PhD - with 20 years experience	900
Agric Economist-MSc - with 15 years experience	500
Senior Monitoring & Eval Officer - MSc-with 15 years experience	550
Veterinarian - with 15 years experience	550
Monitoring & Eval Officer-BSc with 5 years experience	300
Computer data entry operator- BSc - 5 years experience	210
Computer data entry operator- Dip - 5 years experience	200
Secretary-BSc with 2 years experience	180
Drivers	150

Source: Ministry of Agriculture, M&E Division

Table A5.15: Schedule of Computer Requirements

Details	Qty	Unit Cost US$	Amount US$
PRIME*:-			
High Spec PC's	4	3,200	12,800
Mid Level PC's	9	1,840	16,560
Laserjet printers	4	1,760	7,040
PC Backup tape drives	2	320	640
PC Optical Storage Disk drives	2	4,400	8,800
Colour deskjet printer	1	6,400	6,400
Colour Scanner	1	1,200	1,200
A3 Digitiser	1	4,000	4,000
Networking Hardware	Lump		4,800
INDY Work Station	2	10,400	20,800
CD ROM	3	560	1,680
9GB Hard Disk	2	4,000	8,000
Workstation Backup Tape Drives	2	720	1,440
Workstation Optical Storage Disk Drives	2	5,600	11,200
Erdas Software	3	6,400	19,200
SPSS	3	6,400	19,200
Microsoft Office	13	640	8,320
		US$	152,080
Department of Meteorology			
Pentium PCs	2	3,200	6,400
PC Tape Backup Drives	2	320	640
PC Optical Disk Drives	2	5,600	11,200
		US$	18,240
Royal Jordanian Geographic Centre			
Workstation Optical Disk Drive	1	5,600	5,600
PC Tape Disk Drives	2	320	640
Workstation Tape Disk Drives	2	800	1,600
		US$	7,840
Veterinary Department			
Pentium PCs	2	2,080	4,160
Software	Lump		4,000
		US$	8,160

*Note:
Based on each PRIME Staff having a PC with access to a networked printer, with two workstations for TA staff. The Unit having digitiser, scanner and colour printer capability.