Ministry of Environmental Protection, Kazakhstan

Asian Development Bank: TA-4375

Environmental Monitoring and Information Management System for Sustainable Land Use

Draft Final Report: 15th November, 2007

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Note: This Final Report for the ADB-TA 4375 is accompanied by a technical volume ‘Design Guidelines for the SKO Subsystem’, and both volumes are available as Adobe pdf files. Interactive spreadsheets, and data in both original and processed formats are additionally available on CD to be provided with hard-copy versions of the report.

List of abbreviations

BVO	Basin Water Organisation
CAC	Central Asian Country
CACILM	Central Asian Countries Initiative for Land Management
CGIAR	Consultative Group on International Agricultural Research
CSPC	Centre for Sustainable Production and Consumption (local partner NGO based in Almaty)
DEM	Digital Elevation Model
EIA	Environmental Impact Assessment
EIMS	Environmental Information Management System (of MoEP)
EMIMS	Environmental Monitoring and Information Management System for Sustainable Land Use (of Project)
FAO	Food and Agricultural Organisation
FHC	Forestry and Hunting Committee
GIS	Geographic Information System
GoK	Government of Kazakhstan
GosNPCZem	State scientific production centre on land resources and land-use planning
HME	Hydro-Geological Meliorative Expedition (of the MoA)
IAC	Information and Analytical Centre
ISRIC	International Soil Research and Information Centre
MIS	Management Information Centre
MoA	Ministry of Agriculture
MoEP	Ministry of Environmental Protection
NAP	National Action Plan
NEAP	National Environmental Action Plan
NGO	Non Governmental Organisation
OblVodkHoz	Oblast (SKO) Hydrological Design Institute
OECD	Organisation for Economic Cooperation and Development
PSR	Pressure-State-Response
REAP	Regional Environmental Action Plan
RK	Republic of Kazakhstan
SALRM	State Agency (of the Republic of Kazakhstan) for Land Resources Management (‘Land Use Agency’)
SKO	South Kazakhstan Oblast
SLM	Sustainable Land Management
SLMIS	Sustainable Land Management Information System (component under CACILM)
SO	Selskiy Okrug (equivalent to Sub-District; commonly corresponding to one or more former state or collective farm boundaries)
SRPCL	State Research and Production Centre of Land Resources and Land Management, subordinated to the SALRM
TAMU	Technical Assistance Monitoring Unit
ToR	Terms of Reference
UNCCD	United Nations Convention to Combat Desertification
UNCSD	United Nations Commission for Sustainable Development
USEMS	Uniform State Environmental Monitoring System

Executive Summary

This report marks the end point of the field trial period in the South Kazakhstan Oblast (SKO) and the establishment of the SKO Subsystem of the EMIMS. The SKO trial period began with preparations for the second Project Workshop and Project Steering Committee meeting held in Shymkent on 3rd and 4th April, 2007 and ends with the completion of the fieldwork, staging of the final and fourth Project Workshop on 23rd October, 2007, and delivery of this Draft Final Report in November, 2007. The Consultants first mobilized for the Project on 14th October 2006 and started work on Monday 16th October, following the notice to proceed dated 7th October 2006. The Project will be completed on or around 15th December, 2007, on delivery of the accepted Final Report.

With this report the Consultants are appending their updated draft for the ***Design Guidelines for the SKO Subsystem*** (with 8 Annexes, 153pp). This includes a revised list of indicators and parameters of land and water degradation, and various technical annexes including material of other agencies included on the system, technical procedures developed by the project including internal (GIS) and external tools and field procedures, a separate report on rangeland monitoring and the Guidelines for Environmental Auditing of Agricultural Enterprises and Farms.

For the **SKO trial period** the consultants moved the base for their operations to Shymkent, capital of the SKO, with an office in the SKO Akimat's Department of Natural Resources and Nature Use Protection. Three graduate technical staff have been recruited, each with a background in the key partner agencies which contribute data and will be intended beneficiaries of the SKO Subsystem. These are: the various offices of the Akimat, GosNPCZem, the SKO University, and the Statistics Agency. Other partner agencies working with the Project are: the Hydro-geological Meliorative Expedition (HME), OblVodkHoz, the Basin Water Organisation (BVO), KAZHYDROMET, the Selection-Genetic Centre on Arid Plants of Kazakhstan and the MoEP's SKO Office. The three graduate staff, backed up by the CSPC team in Almaty (and one CSPC staff member working in the Shymkent office), and together with the International Consultants, continued with development of the System for the April-October Project Period. Costed (but tentative) proposals have been made for the continuation of work on the system after project-end, and for replication of this work to other Oblasts in the country.

The **SKO Subsystem** is based around a flexible and portable GIS/MIS system embracing *ESRI ArcGIS9.2* software *(ArcView, ArcEditor,* and *SpatialAnalyst* packages) and *Microsoft Office's Excel* and *Access* spreadsheet / database packages. Hardware includes two desktops and two laptops (one of each of which are high-specification), two GPS devices, two printers (one for a partner agency) and two further desktops (both for partner agencies).

Major challenges that the project has had to face have included:

- **logistics difficulties** with work split between three widely-spaced centres: Shymkent (trial Oblast and SKO Subsystem); Almaty (office base for CSPC and HQ for many of the key technical agencies); and Astana (HQ for the MoEP, the IAC, and other National Ministry offices and agencies);
- a **heavy programme for workshops (4) and reporting (4, plus technical annexes)**, in relation to the International Consultant's staff months available (only 5 SM for the Team Leader and 3.5 SM for the other two staff);
- the Consultants' teams involving a **large number of staff with mostly very short inputs**: this has complicated problems of briefing and logistics, report writing and editing;
- the **size and complexity of the SKO**: the oblast is of the same size and shows the same physical and geological complexities of England; and administratively both rayon and selskiy okrug boundaries are very tortuous and have shown many changes over the last 30-40 years.
- the **need for liaison with a large number of partner agencies**, both at Oblast and at national level, and the need for considerable time for institution-building (not least in explaining the immediate objectives of the work, and also the potential benefits of the proposed system to each of the partner agencies) in the setting-up of the SKO subsystem;

- **major problems of data acquisition**: this has been by far the biggest problem. Although the overall data portfolio is good (with much excellent Soviet baseline and basemap data being retained and the land database under GosNPCZem having many excellent characteristics), free data exchange between Government Ministries and Offices is not occurring. Many offices are now privatised agencies and insist on charging for provision of collected data, and the cost of acquisition of such data is prohibitively high.

In **design of the EMIMS SKO Sub-System** the project has had four major principles and objectives:

- to define and then focus on the **indicators of land and water degradation** that will be of ultimate benefit to the SKO institutions, the Kazakhstan National Government and agencies, and CACILM and the International Funding Agencies.
- to set up a system that is workable at **four different scale levels**: Oblast (c.1:200.000), Rayon (c.1:50.000), Selskiy Okrug (c.1:25.000) and farm enterprise levels (c.1:5.000);
- in spite of the major problem of data availability and cost, to base the system on a small **selection of real data** rather than to design a theoretical 'empty-shell' system;
- to embrace existing national practise and to maximum extent the **excellent baseline data, mapping and studies** inherited from the Soviet period, but at the same time to **incorporate international practises** and some relevant new ideas and data sources (e.g. rainfall-runoff modelling and infiltration criteria; use of Google Earth imagery, and other modern approaches).

Major findings and outputs of the project are summarised in the next section of this report: ***KAZAKHSTAN EMIMS: Summary and Conclusions on Major Findings and Outputs of Project.***

Accompanying this report is the definitive draft of the ***Guidelines for EMIMS SKO Subsystem Design.*** These Guidelines plus key findings from the present study were presented to National and SKO staff at the Project's Final Workshop in Shymkent on 23rd October, 2007.

Also included in the report are **draft proposals for future work** needed at three levels:
- i. continuing work at the SKO level with the existing SKO subsystem and staff:
- ii. work at National level in absorbing the SKO system and data and setting the framework for the replication of this subsystem throughout the other 13 oblasts of the country;
- iii. the routine replication of this work among these other oblasts.

The major cost element at all three levels would be the purchase of the necessary data from the privatised agencies. These sums would be so large that Government may well consider that re-negotiation on cost and conditions with these agencies would be necessary. Another possibility here is that money would be paid to these (mostly privatised) agencies in return for improved updated monitoring and survey activities (the excellent recent soil / bonitet assessments surveys of the GosNPCZem are a case in point: there would be a strong case for replicating these as quickly as possible throughout the SKO, and then onto SOs in other Oblasts in the country).

The staffing and routine office operation costs of the continuing work on the SKO Subsystem are modest: some $2000/month being the baseline case (excluding costs of data purchase).

Lessons learnt to date from the Project are the following:
- the institutional set-up with the 12-14 partner agencies and offices can serve as a workable model for the other oblasts; the agencies were all interested, technically very competent, willing to cooperate and most, if not all, will potentially benefit from the system in the future;
- the introduction of GIS/MIS technology has proceeded rapidly only in GosNPCZem (who now have an advanced set-up covering land resources and property cadastres). Other agencies could greatly benefit from GIS/MIS (and links to GPS and digital field recorders), most notably the three agencies dealing with irrigation and water issues (OblVodkHoz, BVO, HME). Associated with the introduction of new technology is a need to consider changes to

work methodology both in the field and also in the laboratory and office. Such changes would improve greatly work productivity, cost effectiveness, and precision of information.

- the Oblast EMIMS Subsystem (and Project) has been based in the Oblast Akimat, and that has potential long-term advantages with respect to use of information on land and water degradation for future planning and implementation of rehabilitation activities. The Sub-system equally could have been based at GosNPCZem: that would have had advantages in terms of immediate access to information and use of existing GIS resources, but might not have been so advantageous in long-term applications of the work.
- splitting project activities between three centres (SKO / Almaty / Shymkent) proved to be problematic, particularly for such short consultancy inputs: any future activity should be based from one centre (ideally the capital city of each respective oblast);
- a senior technical staff member should have a long-term (2-year) posting in each respective oblast to set up the oblast sub-system. Ideally, that staff member would be from IAC, Astana, seconded to the oblast akimat for the 2-year period;
- the three local mid-level technical staff appointed to acquire data and to run the SKO Subsystem all worked very well and this model should be extended to other oblasts.
- there is much interest from farmer's groups in the practical application of the SKO Subsystem at farm level, and particularly the dissemination of data on soil fertility, fertiliser requirements, potential cropping information, and in securing potential funding for land improvement (e.g. soil conservation) activities.
- if ADB or other internationally-funded agencies show continuing interest in these activities, there is a strong case for a long-term externally-financed TA to assist in further development work on the system. Part of this TA's brief would be to promote inter-agency cooperation and result-focussed institution building at both oblast and national levels (a necessary aspect which was under-emphasised in the current consultancy ToR). Another part would be on workshop and training activities, both in Kazakhstan and, using the Kazak experience, in the other CACILM countries.

1 Introduction and Background

1.1 Introduction

ARCADIS/EUROCONSULT has been contracted by the Ministry of Environmental Protection of the Republic of Kazakhstan to undertake consultancy services on the ADB-financed TA 'Environmental Monitoring and Information Management System for Sustainable Land Use'. The project is one of three related projects funded by the Bank and follows closely methodology already established by the previous work.

The Consultants mobilized on 14th October and started work on 16th October, 2006, following the 'notice to proceed' dated 7th October. The contract formally runs for a period of 14 months from the start date of the project. Consultancy inputs have very closely followed those stipulated in the Inception report, which in turn made only modest changes to what were given in the Consultants' original proposals. These changes included: both the International GIS/MIS specialist and the International Environmental Monitoring and Auditing specialist had revised inputs of 3.5 staff months each; part of the input of the latter specialist plus that of the team leader was re-scheduled into the period late-January / early February, 2007; and nearly all the expatriate inputs have been scheduled to be spent in Kazakhstan, rather than a proportion of them (for reporting) in the individuals' home countries. Shortly before the last inputs of the expatriate staff, however, the GIS/MIS specialist resigned for personal/health reasons, leaving his remaining inputs to be filled by the Team Leader. The consultants were initially based in Almaty at the local associate's (CSPC's) offices for the first part of the project, but the project moved to Shymkent, the capital of the trial oblast (SKO), as of 10April07.

1.2 Scope and Structure of this Report

Chapter 2, Work Undertaken by Project, begins with major project milestones (2.1) and a discussion of the main points raised in the three Project Workshops and Steering Committee meetings held so far (2.2). Activities are then discussed under Procurement of Equipment and Software (2.3), the Shymkent Office and Staff (2.4), and liaison with the SKO partner agencies (2.5). The comments received on the Indicators of Land and Water Degradation are next discussed (2.6). The availability and quality of maps and other geo-referenced data forming the backbone of the SKO Subsystem are then described (2.7). Next follow two sections on work developed by the Consultants: Environmental Auditing of Agricultural Enterprises and Farms with reports now completed on six sites (2.8), and the work being undertaken on Sprinkler Infiltration rates and applications to rainfall-runoff modelling (2.9).

Chapter 3, **Work Undertaken through Partner Agencies**, begins with a background section (3.1) before dealing with activities undertaken under each of the partner agencies, including GosNPCZem (3.2), SKO Statistics Agency (3.3), KAZHYDROMET (3.4), and Hydro-Geological Meliorative Expedition (3.5).

Chapter 4 deals with **Lessons Learnt and Proposals for Future Work**. The first section (4.1) deals with Lessons Learnt in the project and further application of these lessons to future work. Draft Proposals for Future Work is next covered (4.2): this includes further work on the SKO Subsystem in Shymkent; further work based in IAC, Astana, but liaising with the SKO and the other Oblasts; and replication of the results of the trial oblast methodology to those other Oblasts.

Chapter 5, Summary and Conclusions on Major Findings and outputs gives briefly the major results and conclusions of the work undertaken on the project to date and the reference in this Report or accompanying technical Guidelines volume to further information on each of the 22 specific subject areas described.

Eight technical annexes are finally presented **(Annexes A to H)**. Also accompanying this report are the draft ***Guidelines for EMIMS SKO Subsystem Design***, which in turn includes eight technical annexes.

2 Work undertaken by the Project

2.1 Major Project Milestones

Major milestones in the project to date have been the following:

07Oct06	Notice to Proceed issued by Client to Consultants
14Oct06	Mobilisation of Consultants (Team Leader: Dr Chris Hatten; and Environmental Auditing & Monitoring Specialist: Stefan Michel)
16Oct06	Work started, based at CSPC Office, Almaty.
20Nov06	Completion and Delivery of the Draft Inception Report of the Project
02Dec06	Receipt of comments on the above report from ADB and from IAC-MoEP
10Dec06	First Project Steering Committee meeting: held in MoEP premises, Astana, Chaired by Mr Braliev, Deputy Vice Minister, MoEP
11Dec06	First Project Worskhop: held in MoEP premises, Astana, Chaired by Mr Bulat Bekniazov, Director, Ecological Problems, Science and Monitoring Department, MoEP
08Jan07	Completion and delivery of revised *Draft Project Inception Report*
20Jan07	2nd (and Additional) input for TL (extending to 04Feb07)
21Feb07	Completion and delivery of *Draft Guidelines for Environmental Auditing* (EnvAudits1.doc)
28Feb07	Completion & delivery of paper on *Land Degradation Indicators* (IndicatorsReview1.doc)
05Mar07	Completion & delivery of *PrelimOutline for SKO Subsystem Design* (EMIMSoutline1.doc)
22Mar07	3rd input for TL (extending to 13Apr07: based both in Almaty and in SKO)
26Mar07	Final list of quotations compiled for Project Equipment Procurement.
03Apr07	Second Project Workshop: held at SKO Oblast Akimat: Chaired by Mr Mamitbekov, Deputy Akim i/c Finance, Economics and Planning, and Mr Bragin, Head, Legal and International Relations Department, MoEP, Astana.
04Apr07	Second Project Steering Committee meeting (SKO): Chaired by Mr Bragin, MoEP.
10Apr07	Project formally moves base to office in SKO Akimat Department of Natural Resources and Nature Protection
19Apr07	ESRI *ArcGIS9* (temporary license) GIS software installed for SKO Subsystem
23Apr07	New SKO technical staff (3) with backgrounds in GozNPCZem, SKO Akimat, SKO Stats Agency, SKO University, recruited and given basic GIS/MIS training;
26May07	4th input for TL (extending to 26Jun07, and based in SKO)
18Jun07	Third Project Workshop and Steering Committee meeting: SKO Oblast Akimat, Chaired by Mr Bragin, Head, Legal and International Relations Department, MoEP.
19Jun07	Project Workshop continuation: presentation to Mr Bob Everitt, ADB Senior Natural Resources Adviser. Chariman: Mr Bragin, MoEP.
Mid-July	Completion and delivery of Mid-Term Report and Guidelines; Installation of definitive GIS software in SKO office.
25Sep07	Formal resignation of GIS/MIS international expert due to personal/health reasons.
04Oct07	5th input for TL (extending to 28Oct07 based in SKO; and to 21Nov07 for reporting, based in UK)
23Oct07	Fourth Project Workshop and Steering Committee meeting: SKO Oblast Akimat.

2.2 Project Workshops and Steering Committee Meetings

The first project workshop and steering committee meeting (10-11Dec06) endorsed the main proposals put forward in the Project's Inception Report regarding staffing and staff scheduling, the outline of the proposed system, the project's assessments of the environmental problems facing the SKO, the preliminary ideas on the indicators of land and water degradation, and the items for procurement. The Project's concern and frustrations regarding data availability (lack of free exchange of data) was also noted. The Team Leader complained that firstly information was clearly not freely available, and also that information about information (i.e. metadata) was also not available. The Team Leader was requested to make specific requests for very specific data (and this was done in the week following the workshop ending in official signed letters from the MoEP to the various offices and agencies concerned). The workshop and steering committee, being held in the new and impressive Ministry premises in Astana, also raised the profile of the project and of the IAC among the National Ministries and Agencies.

The second project workshop and steering committee meeting (3-4Apr07) was held in Shymkent and sought to achieve a consensus among the potential 12 partner agencies and offices and define their roles with respect to the proposed functions of the project, and also the possible benefits that the project could bring them. Draft protocols were drawn up between the project and these agencies and offices to cover these work arrangements. The Project was also requested to include the SKO University in its list of partner agencies. Possible sites for the proposed SKO Subsystem office were discussed, the two short-listed candidates being GosNPCZem (advantageous for data access and for GIS/MIS development grounds), and the SKO Akimat (advantageous in terms of potential long-term application of the subsystem information). The Committee decided on the latter option, and an office in the building of the Akimat Department of Natural Resources and Nature Protection was allocated to the project. Possible candidates to fill the proposed posts of technical officers to implement the SKO Subsystem were selected from the key partner agencies: GosNPCZem, the Akimat, the SKO Statistics Agency and the SKO University.

Also discussed at the second project workshop were the three draft reports produced by the project.
- *Selection of Indicators for the Environmental Monitoring and Information Management System for Sustainable Land Use* (review of CACILM, LADA, RETA-6155, and OECD documents and tentative proposals for EMIMS indicators);
- *Methodologies and Operational Guidelines for Environmental Audits of Agricultural Enterprises and Farms with respect to Land Degradation and Water Quality Concerns*;
- *Environmental Monitoring and Information Management System for Sustainable Land Use (EMIMS-SLU): Preliminary Outline for Proposed System Design*.

The paper and the consultants' proposals on the list of indicators attracted many comments, most of which were minor. The more fundamental comments (plus the comments from ADB) are discussed in Section 3.6 below.

For the environmental auditing work the project had drawn up a long-list of 10 possible sites spanning a wide range of agro-climates and potential environmental problems and on which it was proposed to undertake fieldwork on four of these. However, locations given by our partner organisation proved to be inaccurate and none of these ten sites proved to be in areas covered by the detailed GoogleEarth imagery (needed because of the lack of access to detailed topographical maps). Alternative sites were thus sought and ideas for suitable locations were given by the workshop participants. Also presented and discussed in the workshop was a paper on rangeland survey and monitoring work, important as rangeland (and haylands) cover some 90% of the SKO and range degradation has recently become much more severe around the many sites of permanent human settlement (nomadic grazing being much less problematic, in this respect).

As with the first workshop, the second workshop also discussed the project's difficulties in obtaining information from the various agencies. Responses to the formal letters signed by the Deputy Vice Minister, MoEP, had met with the response that information could be provided, but that a standard charge would be made (the charges in the case of both GosNPCZem and KAZHYDROMET each being several times the Project's total available budget). Heated discussions were had on this among the various participants, the two sides of the argument being on the one side that Kazakhstan had both internal and international commitments on free availability of national data, and on the other that many of the agencies had to be self-financing and they could not survive if they gave their data away free of charge, even if this was to another branch of Government.

The third project workshop and steering committee meeting (18Jun07) reviewed and discussed the revised list of indicators, the proposed guidelines for system design, and the progress of GIS/MIS development, environmental auditing activities, and other developments. The Team Leader was specifically asked to show how each of the main groupings of proposed indicators would link with the raw data being entered onto the system, and to discuss these links under the following format:

- Data availability;
- Data input and quality control;
- Data calculation and processing;
- Data output;
- Remarks.

This format was then followed for discussion and analysis of each of the following groupings of indicators:

- Socio-Economic: Crop Areas and crop Yields (1);
- Socio-Economic: Changes in Crop Profitability (2);
- Biological: Reduction in 'Net photosynthetic productivity' and reduction in 'Useful Biological Productivity' (3);
- Physical / Fertility Indicators: reduction in soil organic matter and available nutrients (4);
- Physical / fertility Indicators: salinity increase (salinisation) (5);
- Physical / Erosion and runoff Indicators (6).

The revised *Guidelines for System Design* follows the above format, and these Guidelines are appended to this report.

Discussion during the workshop, steering committee meeting, and further presentation on the following morning brought up the following points:

- reliability of some of the Statistics Department data was questioned (this is based on sample data and not on a full census): however, sampling criteria and methodology have met (or exceeded) international (e.g. EU) standards;
- GosNPCZem in the Selskiy Okrug soils and bonitet reassessment reports are including much more reliable data on crop statistics and on key meteorological data, as well as detailed work on soil reassessment. Crop yield data needs to be related to bonitet ratings for the land in question, and this is being (partly) done in the SO reassessment mapping and reporting. (This is indeed excellent work, but does not give full coverage: nevertheless, the Project and SKO Subsystem has sought to maximise use of this information).
- GosNPCZem bonitet reassessment information should be used as a key indicator. (The project again has sought to do exactly this and has amended the list of indicators accordingly).
- GosNPCZem have stationary monitoring sites (SES) and these should be used to the full extent (Yes);
- Some information, routinely collected during Soviet days, is not collected now – e.g. detailed salt profile information (salt is highly mobile, and the salinity problem will change week-by-week). For salinity, rapid overall assessments (say using easy-to-make EC measurements on 1:2,5 soil water suspensions in the field) are needed, rather than detailed and expensive analytical determinations on soil paste extractions of anions and cations.
- A Government Metadatabase (i.e. a data base on data held by all government and privatised agencies) needs to be compiled. Data on this database should be available for different users, and protocols drawn up for information sharing. (However, some Government agencies have to be self-financing: some at 100% of activities, others at say 70%, and this requirement complicates enormously the potential free information flow);
- Farmers' organisation representative: individual farmers urgently need information on the type of soil they have and how it should be managed for maximum yields and profits. How can individual farmers get the information they need? (The intention of the SKO Subsystem would be to provide generalised information through the Project / IAC website: specific information on specific parcels of land (e.g. environmental audit reports) could also be provided, but it would be intended that a charge would be made for this).

The fourth project workshop and steering committee meeting (23Oct07) reviewed and discussed the major findings and outputs of the project as presented by the project team. This covered the guidelines for system design, data requirements for the system and the progress in the acquisition of this data, the progress of GIS/MIS development, environmental auditing activities, the fieldwork undertaken on infiltration experiments, the linking with this and the meteorological data in the rainfall-runoff modelling and the drought analysis work, the accumulation of soils and land resources information available to the project, the work on rangeland monitoring and the interesting work on the three trials sites over the period 1990-2000, and the analysis of soil organic-carbon stocks. The potential of soil and the vegetation it supports as further carbon sinks was explored, as were current and likely future developments under the Kyoto protocol. The requirement for accurate monitoring data at the appropriate level of precision was emphasised. Presentations were also made on the changes of land use and agricultural output since the end of the Soviet period (comparisons of data of 1987 and 2004), and the environmental auditing work undertaken on the six agricultural enterprises by the project. Proposals for follow-up work were also discussed, in relation to the many lessons – both positive and negative – which were obtained from the trials work over the previous seven months. Scope of work and tentative costings were also presented in these proposals.

2.3 Procurement of Equipment and Software

It was decided within the first six-weeks of the Project that the SKO Subsystem should be based around a flexible and portable GIS/MIS system embracing *ESRI ArcGIS9.2. ArcGIS* was the software being used by the IAC-MoEP and also by the GosNPCZem, and it would have been irrational to look to alternative packages. (Both *MapInfo* and *AutoCAD Map* were considered and quickly rejected). *ESRI ArcView* (2 units)*, ArcEditor,* and *SpatialAnalyst* packages, and *MS Office's Excel* and *Access* Spreadsheet / Database packages were chosen to be the backbone of the system. With work being completed in at least four locations (Shymkent - probably also from several centres; Astana; Almaty; SKO rayon offices) it was decided to go for a portable system based on laptops. A total of some $22.000 was earmarked for these items on the basis of tentative prices being quoted by suppliers.

With interest being expressed in possible acquisition of a portable field analysis kit (for soil and groundwater salinity and anion / cation composition; for soil fertility analysis; and for heavy metal analysis) the balance of $8.000 of the $30.000 total was earmarked for the purchase of a Hach Kit (or equivalent, from another manufacturer.

The Project's decision on hardware and software was endorsed by the first project Steering Committee meeting on 11Dec06. Approval was obtained from ADB for procurement of these items, with 3 quotations being required from suppliers and the project having to go for the least expensive supplier of each item. Quotations were completed on 26Mar07, but no local suppliers for the Hach Kit equipment were found and selection and ordering of such equipment was beginning to be an extremely time-consuming activity. Also it became clear that further desktops needed to be ordered for partner agencies (SKO KAZHYDROMET and CSPC, Almaty). In addition, there was a strong desire on the part of some project staff to have desktop rather than laptop units for the main system. Also the cost of both hardware and software was significantly more than that originally earmarked, and the Hach Kit was thus deleted from the list of items. Hardware finally purchased thus includes two desktops (1 high-spec) and two laptops (1 high-Spec), a lazerjet printer, two GPS devices (relatively minor items, bought from the survey budget), and two further desktops and printers (for partner agencies). Delivery was effected for these hardware items in mid-late April.

For software various bureaucratic delays (concerning licensing agreements) affected timely acquisition of these packages, but in the meantime the software suppliers issued temporary licenses so that work could proceed. The bureaucratic problems were finally overcome by early July, and the software was rapidly acquired and installed.

The project, and, to an even greater extent, the partner agencies, are all still very interested in the possibility of acquiring some Hach Kit equipment and the project was keen to pursue this with the contingency funds. (Cost of chemical analyses with the Hach Kit equipment and reagents is no more expensive than with conventional methods, and the Hach Kit gives much greater flexibility in terms of repeat sampling and rapid further analysis once problems are identified in the field.)

2.4 Setting up the SKO Office and Recruitment of Staff

On 10Apr06 the SKO akimat allocated a small office in the building of the Department of Natural Resources and Nature Protection for Project use. This is conveniently situated, has reliable electricity and air conditioning, and has sufficient room for 4 or 5 people to work. Four desks and a cupboard/bookshelf were made available (one further small desk was later added). The consultants subsequently purchased a lockable filing cabinet, and repaired the air conditioner, and in the following week installed computer and ancillary equipment (printer, UPSs, wiring/adaptors, fax modem etc).

Three local graduate staff were then recruited for the further duration of the project:

Mrs Laura Seidualieva: Office manager / administrator, responsible for overall local management and liaison (particularly with the Akimat and with the SKO Statistics Agency). Mrs Seidulalieva has a postgraduate degree and previous work experience in the Statistics Agency.

Ms Karlygash: GIS/MIS and IT specialist, with work experience from GosNPCZem. Ms Karlygash has been working effectively from both offices, undertaking the liaison work with GosNPCZem, which is essential to the project. She has specialist training in ArcGIS, as well as being very knowledgable on the soil and bonitet survey work that has been completed by GosNPCZem.

Ms Jazira: GIS/MIS and IT specialist, from the SKO university, having particular experience in database programming and administration, as well as in GIS and environmental applications.

Some administrative delays have been experienced in the ordering of the GIS software, but in the meantime the Project was able to install the same software under a temporary license, and further conduct some on-the-job training exercises with the staff. The fact that all three local staff members have experience in a wide range of software applications, and some background in GIS/MIS work, has made this training considerably easier.

2.5 Liaison with SKO Partner Agencies and Offices

Key to the long-term success of the overall objectives of the project lies in its relationships with the various partner agencies and offices at SKO level. The characteristics of each of these partner agencies and offices are shown in the appended **Guidelines Table 1** (large format - A3 – table), which gives specific information for each agency on the following:

- data held, with respect to land, water and environmental maps and data of interest to the Project;
- office facilities and staff numbers within the SKO, both in Shymkent and in rayon or local offices;
- extent of existing computerisation of activities;
- the extent to which GIS and computerisation of mapping and geo-referenced data is undertaken;
- the extent to which their work is applied to monitoring and rehabilitation of degraded land and water resources;
- possible advantages and disadvantages in the organisation being considered for housing the facilities for the SKO subsystem.

The relationship of the project to these various SKO partner agencies and offices, particularly in terms of information flows and eventual project outputs, is shown in the appended **Guidelines Figure1**.

Close liaison has been maintained with most of these agencies and offices, particularly from early April, 2007, when the base for the project moved to Shymkent. This liaison has been time-consuming, but it has been considered very necessary, as it forms the basis on which further work and cooperation can be based. Such inter-agency coordination and cooperation would have appeared to have been largely lacking in previous projects (which have invariably been centred on only one agency), and in this respect the project has broken new ground. The project now has accumulated much experience on what information each of the agencies and offices hold, the quality / precision of this information, its value with respect to the EMIMS SKO subsystem, and the actual and potential costs involved in the SKO Subsystem's future acquisition of this data from the respective agency.

2.6 Proposals and Discussions on Indicators of Land and Water Degradation

On 28th February 2007 the Consultants completed and delivered a draft paper on Land Degradation Indicators (IndicatorsReview1.doc) including a two Excel tables (LandDegIndicators1.xls) summarising the main indicators of degradation for both land (sheet 1) and water (sheet 2). These documents were translated into Russian, and both English and Russian documents attracted much discussion. The main discussion points were the following:

1. The **Spatial Dimension** in the Indicator List would appear to be missing. Areal changes at different scales should be included, and should apply at different levels – i.e. Oblast, Rayon, Selskiy Okrug and Farm Enterprise Levels.
2. **Carbon stocks need to be included.**
3. **Erosion Indicators should include the different erosion levels mapped** by HME or GosNPCZem, e.g. classes at >15tonnes/ha/yr, >30 tonnes, >60 tonnes etc.
4. **Bonitet Assessments** (Land Capability Assessments made in the Soviet period and continued to be updated to the present day) need to be included as a key indicator. They are certainly much more reliable and valid than are the crop survey data (undertaken by the Stats Agency).
5. **Agrobiodiversity** should be included in the list of indicators.
6. **Social indicators should be more reflected in the indicator list.**

Most of these points have been incorporated in the latest revised list of indicators, and the subsequent work based on these. Further discussion on these comments was presented in the Mid-Term Report.

2.7 Maps and other Geo-referenced Data considered for inclusion into the SKO Subsystem.

A large amount of baseline and basemap information needed to be put on the GIS/MIS in order to form the base material from which the land and water degradation indicators would be calculated. This material, and due comments on quality and applicability of this in the SubSystem, are as follows:

Topographical coverage at 1:1million scale. This represents good general basemap material for entire-oblast mapping. Contour intervals are at 50m intervals at lower elevations, 100m intervals at higher elevations. Streams, reservoirs, major canals and major roads and railways are all shown. Some shape (shp) files and linked database (dbf) files are available from the Protected Areas and the Forestry Cadasters of the IAC. This material was made available as ArcGIS vector files from IAC-MoEP (Astana) to the consultants and to the SKO subsystem. These vector files unfortunately do not have rayon and SO boundaries, nor rayon and SO centres. (SO centres have now been identified and digitised by the Consultants; SO and rayon boundaries are in the process of being obtained and added to the GIS.)

Topographical coverage at 1:200.000 scale. Printed maps showing considerable cartographic detail are freely available. Also freely available are JPEG scans (raster format), which can be georeferenced as basemap material. This material shows detailed town and village / hamlet place names and topographical contours at 50m intervals. A problem of copying of equivalent material in ArcGIS format from the IAC-MoEP prevented the consultants using the equivalent ArcGIS vector files directly in Shymkent until very late in the project, but this was eventually resolved.

Topographical coverage 1:50.000 scale. This coverage is available under GosNPCZem, but current Government legislation deems this to be a state secret and it is not freely available to other Ministries or Agencies. But this information is available to GosNPCZem for its applied and commercial (fee-paying) work over a wide spectrum of the land sector. Change of Government legislation on this is needed (to bring Kazakhstan in line with normal international practise), but this task is well beyond the remit of the present project.

***Google Earth* imagery:** (see **Box 1**).

Box 1: *Google Earth* Imagery:

The entire SKO is covered by *Google Earth* imagery, available free of charge over the internet. However, fast broad-band access is almost essential to download firstly the free software and then a reasonable amount of imagery within a reasonable time. Note frequent updates are made to this software, and different features are available under the different versions of this software. Note also that additional functions are available (e.g. links to *ArcView* GIS for integrating the imagery with existing GIS coverages; and to *MapSource* GPS software, for downloading GPS points onto a base represented by the GE imagery), but different rates of annual charges are made to access these functions. The most expensive version with full functionality – *Google Earth Professional* – costs some $400/year.

Nearly all of the GE imagery for the SKO was acquired during the last 3 years and much is of the summer period of 2006. Precise date of the imagery selected for the free GE coverage (generally the best quality available of the last 3 years) is obtainable from the command sequence: View~ Layers~ Core~ Digital Globe Coverage~, as is alternative imagery for the same area, and ordering procedures for specific (hard copy) photographic materials.

The consultants have spent many hours (in their home countries) downloading through fast broad-band internet access a large selection of the SKO GE imagery, at the highest resolution possible. These downloads are as many JPEG files each of around 1MByte in size, and copies are available for partner agencies and staff on request.

The GE imagery has built-in georeferencing, and a grid-based image can be produced and printed out. (However, unfortunately the coordinate gridlines tend to be arbitrary and excessively dense: no editing facilities appear to exist here, at least in the free versions of the software).

The GE imagery is extremely useful for four main reasons:

- it provides a recent topographical basemap which can be extremely detailed (i.e. 35-45% of the SKO area covered effectively with 1:5.000 - 1:10.000 basemapping, the balance area with 1:65.000 mapping). Also with a photographic base, orientation in the field is often easier than with conventional topographical maps.
- it has a built-in DEM (Digital Elevation Model) which allows landscapes to be viewed in 3-dimensions and also for the elevation exaggeration factor (and the perspective factor) to be adjusted according to the users' requirements;
- it provides essential information on vegetation type, soil conditions (erosion etc) and other environmental problems, at a fixed date (this date information being accessible through the GE menu) and an updated land cover map can be easily made from much of this imagery.
- it provides a basis for purchase of recent high-resolution imagery in both hard-copy and digital format. This imagery also includes a selection of other imagery available for the same area but at different times of the year.

Some 30-35% of the SKO is covered by detailed imagery (equivalent to colour air photography) and all of this will stand enlargement to 1:10.000 scale (and much to 1:5.000 scale). Around 45% of the more important areas near Shymkent and to the E of Shymkent are covered by this detailed imagery, on which detail such as small rills and erosion gullies, and small tracks and even footpaths are clearly discernable. This detailed imagery serves as an excellent mapping base for environmental auditing and other detailed studies on agricultural enterprises. Tonal differentiation for recognition of different crop types, however, is not particularly great with this detailed imagery.

The remaining areas are covered by standard satellite imagery (SPOT, or LANDSAT TM) which is enlargeable to only 1:60.000-1:70.000 scale before pixilation occurs. However, tonal differentiation for this standard imagery is excellent, so that crop recognition and differentiation (e.g. winter cereals, spring cereals, alfalfa, pasture, summer cropping land, other recently plowed land) can easily be made.

Topographical coverage at 1:25.000 scale. (Comments as above for the 1:50.000 mapping also apply). This should form the long-term topographical basemap for any system, but availability to other agencies and Government offices is the major issue. However, the availability of excellent GoogleEarth detailed imagery now makes this material less essential than it otherwise would be. Also, the SO soil maps have much of this 1:25.000 topo information as basemap material, albeit as an undifferentiated black-and-white coverage.

Topographical coverage at 1:10.000 scale. (Again comments as above also apply). SO soil maps again have much of this as basemap material. Again excellent GE detailed imagery can be substituted and serve as a basemap for the areas that they cover (currently 35-45% of the total SKO area).

Soil Mapping, 1:300.000 scale. This represents part of the intermediate-scale Soil Mapping series which was undertaken in the USSR over the period 1955-1965 (in this case by the Academy of Sciences, Almaty). This is at the level of land units / soil associations, and has a very detailed legend with masses of very useful baseline and basemap information. The Project commissioned GosNPCZem to digitise this map (and legends) for two of the mapsheets (each mapsheet covering 2 degrees NS and EW) and this will form a basic baseline tool for the environmental monitoring work.

Equivalent maps elsewhere in the Former-Soviet Union (e.g. Bylorrussian and Estonian SSRs) were cartographically detailed and well-produced, and proved to be extremely useful to the Consultants' work on parallel projects. Soil mapping units (on the digitised maps) were organised so that textural and drainage relationships plus bonitet ratings were clearly discernable, and these features together with soil organic matter now need to be incorporated into a new colour legend for the digitised SKO map.

Soil and Bonitet Assessment Mapping, 1:10.000 and 1:25.000 scales. This mapping was produced for the area of each Sovkhoz and Kolkhoz, now renamed and corresponding to current Selskiy Okrugs. Topographical basemap information here is detailed, and includes field boundaries, drainage features, roads and tracks, buildings, etc.

The main legend on this map shows soil units defined on Soil Type, Code (National List), Soil No (for specific map), soil textural variants, soil parent material, relief, and bonitet range (maximum and minimum values within specified mapping unit), area of total cultivated land (ha), and area of irrigated land within that unit. Adjoining sub-legend area shows areas of land (ha) within specific 5-unit bonitet ranges (e.g. 10-15; 15-20; 20-25; etc).

Each individual mapping unit is labelled with its specific individual bonitet rating (calculated according to the analytical results from the specific samples points within the unit) and the areal extent (in ha) which it occupies. The bonitet assessments were originally undertaken with the first survey report of each area (e.g. 1963 for the Karamurt SO, then called Kirova Kolkhoz), and then reassessments were repeated officially at 5-year intervals during the Soviet Period. (In practise reassessments were made after much longer time intervals.)

Within each individual mapping unit, the soil sampling and analysis points are also shown. Routine analysis includes organic matter % (all points, bulked 0-50cm samples), and soil textural analysis of all the horizons down to c.150cm (about 10% of points). Further routine analysis has been undertaken for some other parameters. Most of this analytical data, however, is still in manuscript format, and urgently needs to be put into Excel tables and linked to the respective point locations on the GIS. The project made a significant start on this and has completed all data for the Karamurt SO.

Recently updated Soil / Bonitet Reassessment Mapping now being undertaken (e.g. Karamurt SO, 1:10.000). Four such recent SO maps (Sairam Rayon) in digital format (ArcGIS shape files) have now been acquired from GosNPCZem by the Consultants. Again analytical data is still in manuscript format, and urgently needs digitising. The legend colours on the original ArcGIS coverages have not been systematised in order to reflect bonitet ratings, and the Consultants have now done this. Map unit colours now range from dark red (reflecting low bonitet soils) through orange, yellow and green to light blue and then dark blue (high bonitet soils).

The Consultants have inspected map legends of the equivalent SO soils / Bonitet Reassessment Mapping of all the SOs in Sairam and Tulkibas Rayons to verify consistency of approach across these two rayons. This work appears to be of high quality and could and should form a backbone for the EMIMS SKO Subsystem. A total of 29 SO Soils / Bonitet Reassessment Reports and Maps have been acquired by the project, and the key data from these is being put on the SKO Subsystem.

Range Vegetation Mapping: 1:200.000 scale at Rayon level; 1:25.000-1:50.000 scales at Selskiy Okrug level. These maps date from the Soviet period, mostly from around 1970-1987 and follow a common methodology. Together the 1:200.000 rayon maps cover the whole of the oblast, and represent useful baseline data. Map units for this mapping are essentially at the level of 'Land Units / Land Facets' of CSIRO (Australian) methodology (i.e. geomorphic / soils / vegetation association units).

The Map Legend covers vegetation associations (up to 5 major vegetation types) plus useful quantitative data on 3 basic parameters of rangeland productivity: (i) palatable Dry Matter (DM) (in centners/ha); (ii) fodder units (in centners/ha); (iii) digestible protein (kg/ha). (Nb: 1 centner = 100kg).

These maps, however, have no grid and no latitude / longitude tic marks, and thus rather time-consuming geo-referencing and perhaps also rubber-sheeting procedures are required to get these into a controlled digital (vector) format. The hardcopy map of Otrar Rayon was lent to the Consultants and high-resolution JPEG scans were completed for full rayon area. GosNPCZem also made available high-resolution scans of three other rayons: Sozak, Saryagash, and Chardara. The Consultants have digitised this mapping for the areas where rangeland monitoring was undertaken (see **Guidelines, Annex G**) and have been able to extract quantitative information for key areas from these coverages

SKO StatsAgency: Selskiy Okrug Data. Data are currently available for 2005 and very recently have also been acquired for 2006, and all of this data is now in digital (Excel) format. Data includes areas harvested (ha), total production (tonnes) and yields per hectare (centners/ha). 4 main crop groupings include grains, potatoes, vegetables, and others. Specific crops within these comprise (in order of value, and order of presentation in pie charts): (1) Vineyards; (2) Berries and Fruits; (3) Melons and Gourds; (4) Vegetables; (5) Potatoes; (6) Sunflower; (7) Safflower (calculated as total oilseeds minus sunflowers); (8) Grains etc; (9) Other Crops (calculated by consultants); (10) Uncultivated Land (calculated by consultants). ArcGIS representation in pie-chart format made by the consultants of this data to show comparison of land use / cropping between the different Selskiy Okrugs.

Figures here are derived on a sample-area basis (and not on a 100% survey basis). Also some important crops (specifically cotton) are not differentiated, but included in the 'other crops' category. Most problematically, rainfed and irrigated crops are not differentiated. However, differentiation at the Selskiy Okrug level is extremely useful, and this annual data now forms a key part of the SKO Subsystem.

SKO StatsAgency: Rayon Data. Rayon Data is available for many more fields (more crop differentiation, irrigated / rainfed, more years) than for the Selsky Okrug data which is available for 2005 and 2006 only.

For irrigated agriculture the following fields are included (2004 data): Grain crops (undifferentiated); Industrial Crops (including cotton, oilseeds); Potatoes / Vegetables etc (incl. potatoes, vegetables, pumpkins & gourds); Fodder Crops (incl. fodder maize; annual leys (incl. for hay and for grazing); perennial leys (incl. for hay and for grazing); Natural Pasture; Fruits, raisins and berries. (Further differentiation of grain crops on season of planting and specific crop, would be useful).

The Consultants obtained the data, available only in hard-copy format, for the years 2000, 1997, 1995, 1990, 1987, and entered this data into an identical Excel format to that already established for 2004. A good comparison was thus obtained on land use and agricultural production changes across the period from the latter days of the Soviet system (1987, 1990), through the period of downturn and restructuring (1995, 1997), to the current period with upturn in most agricultural activities following improvement in world commodity prices (2004).

Socio-economic data is currently only available at rayon level.

Box 2: Bonitet Assessments:

Bonitet assessments were presented for both irrigated and rainfed land for each of the Kolkhozes and Sovkhozes of the SKO (Iorganskiy et al, 1987). Weighted averages were also given for each of the rayons within the SKO, again for both irrigated and rainfed lands. This data is given in this report as Annex X (file:KAZ\V4\BonitetEng3.xls).

For the **irrigated assessment**, totalling 285.303ha, the highest (irrigated) bonitet was achieved by Kolkhoz F.Engelsa with 81 points. The highest weighted average for a rayon was obtained by Leninskiy (now Kazygurt) rayon (64 points): the minimum was 16 points (for Sozak rayon) and the irrigated average for the whole of the SKO was 29 points. Implied in these figures is that the best irrigated land is very productive but the average productivity is low, affected by very large areas of low productivity irrigated land. Nevertheless, irrigation (at least) doubles the productivity of the land across the full range of soil / land types in the SKO.

For the **rainfed assessment**, totalling 819.285ha, the highest (rainfed) bonitet was achieved by Kolkhoz Kuybysheva with 39 points. The highest weighted average for a rayon was obtained by Tulkibas rayon (31 points): the minimum was 8 points (again for Sozak rayon) and the rainfed average for the whole of the SKO was 16 points.

Bonitet assessments have also been made for all individual mapping units on the Selskiy Okrug soil maps originally undertaken at 1:10.000 or 1:25.000 scale over the period 1960-1989. Each individual polygon on the map is labelled with a soil number (e.g. 28r) and adjacent to this is the individual polygon's bonitet rating (e.g. 20.6) with the area of the polygon (e.g. 384,7ha) given below. Reassessments of soil and bonitet ratings have continued to the present, with recent maps being available for many Selskiy Okrugs.

Bonitet assessments represent a useful **single-parameter system for assessing overall land capability** as they relate directly to productivity of vegetation and crops as determined by soil and climate (and irrigation, if applied). Factors of soil water relations (rootable depth, available water-holding capacity, sometimes also infiltration), drainage, salinity and sodicity (alkalinity), and inherent (native) soil fertility and especially soil organic matter content all affect the bonitet assessment. Factors of climate are also included: mean values and reliability of rainfall as it affects soil moisture status during cropping period, temperature etc). Importantly, rehabilitation or degradation of the land can also greatly affect bonitet rating. For example, in Belarus, large areas of land had a bonitet of just 35 due to poor drainage (other factors such as salinity, alkalinity in this case were not limiting). After drainage rehabilitation the bonitet assessment increased to 47 points. An increase of 12 points was thus achieved, and these 12 points could be quantified in terms of a direct increase of grain and fodder crop yields.

For major crops each bonitat point thus equates to production of a certain yield of a defined crop in an average season. Similarly, there are relationships between kg of fertiliser applied and extra crop yield, again for the average season, and for a specified (low) maximum total of fertiliser to be applied (commonly around 50kg N /ha). (As an example, in Belarus for winter rye each bonitet point equated to to 27kg grain / ha and each kg / ha of active nutrient in fertiliser equated to 4.1kg / ha increase in grain yield).

Bonitet assessments in theory were routinely reassessed every 5 years across the USSR. In practise this was achieved in the more productive and more densely populated lands (especially in the westernmost republics) but less systematically undertaken for the less productive or more problematic lands (e.g. those occurring over large expanses of the SKO). Nevertheless, the concept of bonitet rating is considered extremely useful in giving a single parameter to land capability, and because of the vast amount of work done in the past following this concept, and more particularly because these assessments have continued to the present (including assessment of soil organic matter which is included as a routine determination for all samples) it would be recommended that this methodology continue and form a backbone of the EMIMS.

2.8 Environmental Auditing of Agricultural Enterprises and Farms

Following completion of the draft paper *Methodologies and Operational Guidelines for Environmental Audits of Agricultural Enterprise,* many potential sites for fieldwork were investigated and a shortlist of 10 possible sites were drawn up. However, after inspection, many of thee proved to be located in different areas to those stipulated (lack of suitable location maps or GPS positioning being a problem here), and more particularly many had to be rejected as not meeting the criteria required (i.e. being a good illustration of significant environmental problems in different areas; size of enterprise being between particular limits; good records being available, particularly from the Soviet period; presence of interested and cooperative owners; coverage by detailed mapping or detailed GE imagery).

During June 2007, Project staff undertook fieldwork on two enterprises in Sairam Rayon, one enterprise in Tolebi Rayon and a further three in Maktaraal, and short reports were completed for all of these (see **Guidelines, Annex H**). For the first three locations the main environmental problems were soil erosion and decline of soil fertility due to over-use of cultivated rainfed land with insufficient attention to soil conservation measures and crop rotations. Soil samples were taken from the three farms from Maktaraal and one of the farms in Sayeram.

In the Maktaraal enterprises problems appeared to be related to drainability of land and overall poor drainage, plus over-use of the land over several decades for cotton cultivation. Reporting procedures for these Maktaraal farms were updated and revised, and an illustration of this is shown in the **Guidelines, Annex H.)**

2.9 Sprinkler Infiltration Experiments: Results and Conclusions

Infiltration Rate is a key indicator of land degradation, and non-degraded land would likely have infiltration rates sufficiently high that nearly all the natural rainfall would be absorbed and very little, if any, would be lost to surface run-off. Natural ecosystems in a state of equilibrium would adjust themselves so that such a state would exist: root pores, animal channels, surface mulches of organic materials, and soil structure stabilised by organic complexes all help to achieve this. Degraded land, by contrast, is very often accompanied by marked declines in surface infiltration rates. The project thus undertook a program of investigation of surface infiltration rates using a simple sprinkler infiltrometer device which simulates high-intensity natural rainfall. (Such rainfall would be prevalent in the area in the late Spring and again in the Autumn, and during these periods significant areas of cultivated soil would be exposed to the weather.) Details of the method used in these determinations is given in the **Guidelines Annex F, Box 3.1**.

In these determinations a total of 19 different sites were investigated in 10 specific areas. These areas were located in the E and SE parts of the SKO, covering the main region of importance for rainfed agriculture and the main areas of concern for water-induced erosion. These 10 specific areas together:

- spanned an elevation range of some 275m to 1500m;
- spanned a mean annual precipitation range of some 420mm (marginal rainfed area) to 760mm (area of ample rainfall for seasonal rainfed cropping);
- covered a comparison between pasture and cultivated land uses.

All the soils were of predominant silt loam to silty clay loam texture and derived from aeolian (loess) material. Textural differences between the different sites were minimal.

For each of the ten specific areas comparisons were attempted to be made between pasture land on the one hand, and cultivated land on the other. For each of the 19 sites the infiltration experiment was run for two periods, each of one hour, separated by a period of 1 or 2 hours when no water was applied. The experiment thus simulated conditions of a 2-hour, potentially high-erosivity rainfall event.

Results of the investigations are presented in the **Guidelines Annex F, Table F.1 and F2**. **Table F.3** presents results from one of the ten specific areas (two sites times two 1-hour periods).

Main conclusions of the investigations and recommendations for future work are as follows:
i. the maximum water depth that could be absorbed by the soil over the 1-hour period varied between less than 4mm to over 46mm: the former figure would represent a major problem with respect to even normal-intensity rainfall, while the latter would be in excess of all the high-intensity rainfall events experienced in the SKO.

ii. very significant differences were seen with 1-hour infiltration totals between the averages of the 10 pasture sites on the one hand and the 9 cultivated sites on the other. First hour infiltration totals were 23,2mm and 12,9mm respectively; two hour totals were 41,5mm and 23,3mm respectively **(Table F.2)**.

iii. the above differences became even more pronounced when the 3 alfalfa sites were removed from the group of cultivated sites. Averages of first hour infiltration totals were then 23,2mm (pasture) and 8,5mm (cultivated) respectively, and two hour totals 41,5mm and 17,5mm respectively. With respect to soil erodibility and also suitability for sprinkler irrigation a rate of less than 16mm/hr may be considered as low (somewhat problematic) and less than 8mm as very low (very problematic). Most of the cultivated soils had infiltration rates of little more than 8mm/hour and several failed to meet the latter criterion.

iv. in the post-experiment excavations, depths of wetting were observed to be very low, with almost all figures below 10cm and most below 5cm. Given the volume of water applied, the observed depths are indicative of probable very high available water-holding capacities (AWHCs) of the soil (probably in the range 18-25%). A very high AWHC is a very favourable feature, if the soil is then managed correctly.

v. the low infiltration rates of the cultivated soils present major problems both with respect to erosion control and also with respect to possible sprinkler irrigation. High-pressure spray irrigation would be required so that rate of application would be less than the infiltration capacity of the soil. Also centre-pivot systems (which are otherwise very economical if 9- or 10-unit multi-tower systems are installed) would not be very suitable for these soils.

vi. contrary to expectations, no significant differences were seen between areas of different rainfall, or areas of different elevation zone. However, the full climosequence of soils was not adequately covered: the rainfall range spanned only 420-760mm.

vii. future work should be carried out on the areas with rainfall range 150-400mm. It is very likely that much lower infiltration rates would be observed in the latter areas, and that soil dispersion would be more sensitive to salt percentage and composition in the percolating water.

viii. further work on the beneficial effect of alfalfa in crop rotations and through apparent improvement in soil infiltration rates (as well as other soil characteristics) is also justified.

xi. some modifications to the simple apparatus used would be beneficial: use of full-width run-off trays, a small siphon pump, a finer nozzle shower-head, and use of collected rainwater (rather than well-water) would all give more consistent results. Determinations would also be better carried out in Spring and Autumn rather than during mid-summer.

3 Work undertaken with the SKO Partner Agencies

3.1 General

During the trial period (end-April to October) the International Consultants had little allocated paid project time and thus had to delegate most of the work to the three newly-recruited local (Shymkent) staff and the national consultants (CSPC). These staff in turn had to delegate much work to the SKO partner agencies and offices which were the source of the data being obtained. These work tasks are detailed here, and the current state of progress of this work also given.

All of these inputs are deemed to be essential for the eventual success of the SKO subsystem. These tasks relate to both establishing the essential baseline and basemap material on the GIS, and more specifically, and more immediately, inclusion of the specific parameters which are essential for the calculation of the indicators of land and water degradation.

The major aim of all this work has been to have workable models developed using real-world data illustrating the different indicators and parameters of the system and the final data and cartographic output, albeit, in most cases, from just a small sample of the real data.

The specific tasks are outlined below, under headings of each of the SKO Partner Agencies. Each of the tasks below call for specific skills and techniques in GIS, and some on-the-job training with respect to these have been required with all (or some) of the staff involved (SKO project; CSPC; partner agencies). A list of these on-the-job training activities is appended in the **Guidelines, Annex C**.

3.2 Work with GosNPCzem

3.2.1 Digitising and Use of the 1:300.000-scale soils / land units map

GosNPCZem was commissioned to digitise the Shymkent sheet and the adjacent sheet to the East. The work comprised 1 ½ sheets of map detail covering the most important part of the SKO (between 41 20’ and 43 20’ N and 70 to 72 E) and 2 sheets of detailed map legend. A sum of $1800 was allocated for full digitisation of this work and completion of the attribute tables. Note the legend here is complex, and attention had to be given to clarity of presentation and suitable representation (colour on this GIS legend replacing monochrome of the map original). Dr Anatoli Iorganskiy, Faya and Guzaliya helped with the English translation of this legend which needed to be undertaken in both Russian and English versions.

The completed digitised soil map subsequently needed to be overlayed with the agro-climatic map, in turn formed by overlaying the rainfall isohyet map with the elevation zone map. Specific soil properties (e.g. organic matter content) can then be related to the various sub-units generated (i.e. soil vs. rainfall zone vs. elevation zone). All of this mapping is essential for assessments to be made at the oblast level. Map output for this can be considered within the scale range 1:200.000 to 1:1.000.000. The scale of 1:200.000 would be most useful for working maps for field use and also links to work at rayon level. (possible final cartographic output to show the entire oblast on a single sheet).

3.2.2 Generating Point Files from Tables of Latitude and Longitude

Tables of latitude and longitude exist in hard-copy format and these need to be put into Excel. ArcGIS shape files of these points then need to be generated. These cover (a) meteorological stations (now available with the Project, having been provided by Kazhydromet); (b) Rangeland monitoring points (specified in report recently drafted by Stefan Michel); (c) hydromet (river gauging / stream flow) stations (Latitude and Longitude of these points need to be obtained from Kazhydromet). (d) Locations of fieldwork on Environmental Audits of Agricultural Enterprises; and (e) Locations of fieldwork on infiltration experiments. For all of these coverages it is necessary to double-check that these points overlay correctly on the GIS.

3.2.3 The recent (updated) soils / bonitet assessment maps and reports

The recent maps (1:10.000 scale) and reports on detailed soils / bonitet assessments undertaken at Selskiy Okrug level provide excellent up-to-date data on soil organic matter and bonitet assessments (see **Box 2, Section 2.6** for discussion on Bonitet Asessments, and **Annex B** for analysis of the 2006 mapping and reporting on Karamurt Selskiy Okrug). This work would appear to represent an ideal base for land and environmental work at Selskiy Okrug level, with presentation at 1:10.000 scale (or perhaps 1:25.000 for the larger and less intensively-farmed SOs). Incorporation of the very recent and very detailed Google Earth imagery into this work could form a very useful comparison and control, particularly on the current land use and problems like erosion and sedimentation which are clearly visible on this imagery.

Amalgamation of the mapping covering SOs within a rayon could form the basis for mapping and assessments at rayon level, with presentation of this ideally at 1:25.000 scale (or 1:50.000 scale for the larger and less intensively farmed rayons).

This work is detailed and would appear to be of excellent quality. The following tasks needed to be undertaken:

- Compilation of a list of the other reports in this series, the date of fieldwork, and what analyses were undertaken. (Soil OM appears to be undertaken on 0-50cm samples covering all sample points, and mechanical analysis (different size fractions, sand, silt, clay etc) undertaken for 5% of samples: what further analyses were undertaken in each area?)
- Photocopies (or digital photos) of 3 key tables needed to be obtained from each of these reports (as for Karamurt):
  a) areas of different land use;
  b) yields of different crops for last few years;
  c) meteorological data (long-term monthly averages).
  When obtained, these need to be typed into the standard formats in Excel.
- We also need to know what the cost is (per sq km of area) for undertaking this soil survey / bonitet assessment work (broken down into man-days and cost for fieldwork, cost for soil chemical / physical analysis, and cost for office work including mapping and reporting.) We need to know this as there might be a possibility for any future project (in SKO or elsewhere) to provide financial support for this work.
- We also need to compile a list of the original soil survey reports (and dates of field survey) undertaken for equivalent areas to these SOs (e.g. Karamurt SO = Kirova Kolkhoz).

3.2.4 Kolkhoz / Sovkhoz point mapping

Good baseline data exists on both bonitet ratings and production statistics covering both irrigated and rainfed lands of the kolkhozes and sovkhozes of the Soviet period. In many cases the point positions of the Selskiy Okrugs can be used to locate the equivalent points called by a different name under the Soviet period. However, in some SOs there are no kolkhozes or sovkhozes; in other SOs there may be two or more kolkhozes or sovkhozes. Just as in the case of the SOs, the point positions of the kolkhozes and sovkhozes need to be identified. (This is well underway and just needs completing).

On completion of the point shape files the bonitet rating statistics can be added and pie-charts can be drawn up, 100% of bonitet rating equating to 360deg of pie, and the shading for the irrigated rating overlapping that for the rainfed rating.

Where we have updates on the bonitet assessments undertaken at SO level, these updated assessments can be added to the database and a double pie representation can be drawn up to reflect the changes in bonitet over the 20-30 year time period.

3.2.5 Selskiy Okrug centres: point mapping

The work already done by Ms Karlygash on this was greatly appreciated. As already pointed out to her, we should just make corrections / additions to this work in two areas:

- Maktaraal Rayon: about 10 (important) SOs are missing. Apparently the officer from GosNPCZem with the work experience in Maktaraal was away when the work was originally done. Ms Karlygash intends to consulted him on this when he returns. (Please note: Karl Anzlem and Valary of HME also have a lot of experience in this rayon, and should be consulted over the phone if there is any query.)
- Other rayons: a few isolated SOs in other areas are also missing and these need adding the coverage.

3.2.6 Selskiy Okrug boundaries

The Project already has Selskiy Okrug boundaries in ArcGIS format for Sairam Rayon. Apparently, SO boundaries for Sozak, Baidebek, and Ordabasy rayons are also available in this format. SO boundaries for Turkestan rayon apparently are available as MapInfo shape files. Cadastre numbers, English and Russian names, and Statistics Agency codes are being added at the moment to the ArcGIS conversion of this file. The process apparently will be repeated for the SOs of the other 8 rayons. All of this work will need following up.

3.2.7 Digitising of geobotanical (rangeland) mapping

The Project has high-resolution JPEG scans of a number of these geobotanical (rangeland) maps which were undertaken on a rayon basis. These maps now need digitising and geo-referencing, at least initially for the areas around the rangeland monitoring work being proposed by Stefan Michel (see below). A certain amount of coordinate transformation and rubber-sheeting may be required in this process, as the maps appear not to have grids and tic-marks. (Maps should be superimposed onto the 1:200.000 topo maps on a light-table (or window) and suitable tic-points transferred on an area-by- area basis.) For attribute data, the three numerical fields covering total palatable dry-matter (DM), fodder value, and crude protein represent the most interesting information.

The full descriptive information here would appear to be of lower value: see Stefan Michel's note on rangeland type changes and problems of methodology for the fields describing rangeland type. We should consider methodology for devising a more useful and more digestible legend to more clearly reflect the most useful parts of the information given on these maps. Having this mapping in ArcGIS format will be extremely helpful in this respect.

3.3 Work with SKO Statistics Agency

3.3.1 General

The SKO Statistics Agency has been very helpful to the project in provision of all available data at nominal cost. Most of the data has been in hard copy, and this was requested by the project to cover suitable periods over the last 20 years (1987, 1990, 1995, 1997, 2000 and 2004-present). Current data is now being provided in digital format (MS Word, easily converted to Excel), and this represents essential baseline data for the project.

3.3.2 Selskiy Okrug crop statistics

The Selskiy Okrug agricultural data for 2006 was made available put into an identical Excel format to that developed for 2005. This data was then processed so that pie charts were presented in ArcGIS in an identical way to that presented in the **Guidelines Figure 4**.

Changes in cropped areas between the two years (2005 and 2006) can be reflected by two pies of different diameter, one inside the other (the smaller one showing the 2005 data, the larger one the 2006 data). In ArcView the commands for the creation of pie charts are given in the **Guidelines, technical Annex C**.

These selskiy okrug statistics are based on sample surveys with methodology in conformity with international standards (including meeting EU requirements). However, results need to be crossed-checked with the latest GosNPCzem soil and bonitet reassessment surveys undertaken on an SO level, as these reassessment surveys have detailed cropping information over the previous few years (e.g. for 2001-2004 in the case of the Karamurt SO report).

Although we will have data for only the last two years the format will be set for the presentation of this important information for the future. Changes in land use are likely to be very large when viewed at Selskiy Okrug (or more detailed) level, as continued rapid development and workings of the market economy continue to have increasing effect. Marginal rainfed land is likely to be abandoned (for rainfed cultivation); property nearer the urban centres is likely to have a greatly increased value both for 'weekend farmers' and particularly for construction; demands for peri-urban land for residential housing – particularly individual private houses with gardens – is likely to be very strong, as real incomes for most individuals rise; irrigation is likely to become more high tech and much more efficient as water becomes a more valued commodity. Good Selskiy Okrug statistics are thus needed to monitor these changes, area by area.

3.3.3 Rayon crop statistics for irrigated land

The project now has data of 2004 for irrigated crop land, production and yields. A concise tabular format has been developed to show this data, and this information is now in Excel format (see **Annex D**). The project now has detailed data in hard-copy format for the years 1987, 1990, 1995, 1997 and 2000, and this includes a very detailed crop breakdown including much more detail than given in the 2004 format. The key parameters (equivalent to the 2004 data – about 15 primary land use categories) have been extracted from these 5 years of data and put into a series of Excel tables. The key parameters of this need to be put in the same format (as for 2004), so that comparisons can be made across the 1987-2004 period. This has now been done: see graphical output from the GIS, **Annex H** of this report, and also **Figure 5 of the Guidelines**.

Unfortunately, although the crop differentiation here is very detailed (about 80 different categories) this data is only at rayon-level. Nevertheless, the information is of value as it follows similar statistical methodology over the last 20 years. In the future consideration should be given to provision of irrigation statistics at Selsky Okrug level with also links to data on water consumption. However, that will need considerable discussion at National level prior to any changes of direction being made.

3.4 KAZHYDROMET

3.4.1 General

Kazhydromet have long-term meteorological and hydromet records giving a good coverage of the Oblast and going back for many years, at least to the early years of the last century for some stations. These records are of enormous value in work on degradation of land and water resources for the following reasons:

- the rainfall and potential evapotranspiration figures for any growing season will have a very close relationship with rainfed crop yield, and this normally is more important than any land factor in determining crop yield;

- the amount and distribution of rainfall during the spring growing period (March-May) is the most critical individual parameter in this respect, late April and May rainfall being most important;
- medium and long term trends in rainfall patterns again may be much more significant than any land factor in determining trends in crop and rangeland yields;
- however, land degradation may be measured in terms of reduction in yield in relation to actual and potential evapotranspiration and to actual rainfall over the above periods, and this is independent of absolute rainfall and other agromet figures (see analysis and discussion under rangeland, **Guidelines, Annex G**);
- also land degradation may be measured in terms of increase in flash runoff, increase in run-off coefficients, and decrease in soil infiltration. These parameters need to be assessed in terms of both measured daily streamflow figures in relation to daily rainfall figures and to simulated runoff generated from daily rainfall figures and application of a daily rainfall / runoff / soil water balance model.

Although the quality of Kazhydromet data is clearly excellent, the agency is 70% privately financed and in spite of major efforts to obtain the necessary data at nominal cost by the project, Kazhydromet has insisted in charging (at a high cost) for historic data. In lieu of charges, the project has provided a computer for SKO KAZHYDROMET use, and this has been put to good use in the generation and processing of the necessary data.

3.4.2 Meteorological Data

KAZHYDROMET delivered, in Excel format, the 10-day figures covering mean temperature, windspeed, humidity and sunshine for the period 1991-2006 for the Shymkent station (606m amsl), and daily rainfall for that station has also been delivered. Daily rainfall and 10-day windspeed, relative humidity and mean temperature figures have also been delivered for Tasyrak (1122m, NE of Shymkent) and Ryskolova (809m, SE of Symkent).

From the above 10-day agromet figures the potential evapotranspiration (ETo) rates were calculated using the FAO CROPWAT program (Penman-Montieth method). With this data and that from the soil infiltration and associated work, soil water balances and simulated runoff were calculated on a daily basis from the daily rainfall figures using the daily rainfall-runoff model (DLYSLWBsko.xls, and related spreadhseets). This work has now been completed for the Shymkent station, and is reported in **Annex E** to the appended **EMIMS Guidelines**.

3.4.3 Future areas of cooperation with KAZHYDROMET

Two further immediate tasks for the project are the following:
- hydromet station coordinates (latitude and longitude) also need to be collected and digitised (Karlygash).
- maps of Mean Annual Precipitation for the Oblast need to be collected (or devised, if current official maps are not available).

Following analysis of the data already provided, acquisition of some further data may be requested and paid for out of project contingency money (Guzaliya). Such data would include:
- long-term annual and monthly precipitation;
- hourly or 3-hourly precipitation data for certain short periods: the latter would be important for erosivity assessments. (These now appear not to be available for the SKO, but parallel data may be available for other adjacent areas.)

3.5 Hydrogeological Meliorative Expedition (HME)

3.5.1 General

HME are very interested partners. They have a considerable amount of computer hardware peripherals (large format plotters) and GIS software (ArcGIS) which are completely underutilised at the moment, staff training and relevant technical supervision and local budgets being the limiting factors. Elsewhere, HME have inherited Soviet facilities and procedures including reliance on a massive amount of chemical analysis of soil and water at a great density of sampling. They are now both questioning the rationale for this work and are very interested in possibilities for in-field analysis, field instruments and field data recorders, introduction of GPS, and the necessary links to GIS. All of this would increase the speed, cost effectiveness, and precision of the work, as well as facilitating production of higher-quality cartographic output. All of these latter improvements to work output would be greatly beneficial in the monitoring and reporting HME have to undertake in their project work, much of this being funded by ADB and the World Bank. They have recently had a research student undertake a good study on application of GIS, and are very interested in maximum cooperation with the project in pursuing their interests on all of these activities.

The project in turn has been interested in acquiring baseline mapping (paper map at 1:200.000 of entire oblast of irrigated lands of kolkhozes and sovkhozes of about 1980) and more detailed and more recent maps of irrigation / drainage rehabilitation in Maktaraal rayon. In addition use of HME laboratory facilities and cooperation on fieldwork for environmental auditing work has also been of major interest, Valery of HME having worked with our staff (Stefan Michel and Gulya) in their recent work in Maktaraal.

3.5.2 Specific work activities

The Project has just paid $500 to HME for soil analysis for the EA work (mostly for the investigations in Maktaraal rayon, but also for samples from Kara Kazim in Sairam rayon) and results have now been made available. A list of analytical methods HME use in this work, and a table of standards applying for the various parameters also need to be appended.

HME need also to be approached for their analytical data for the surrounding land in Maktaraal and a location map for the relevant sample points. The project also needs the format of all the salinity analysis, and the methodology and reporting.

4 Recommended Future Developments

4.1 Lessons learnt to date and future applications of these lessons

4.1.1 Lessons learnt

The Lessons learnt to date from the Project are the following:

1. The Oblast institutional set-up with the 12-14 partner agencies can serve as a workable model for the other oblasts; the agencies were all interested, technically very competent, willing to cooperate and most, if not all, will potentially benefit from the system in the future. All agencies, however, have specific short term requirements and specific long-term interests, as well as general interests which are common to all agencies (i.e. desire for access to a common database with both essential baseline and basemap data and also updated data reflecting the current situation on environment, land resources, and land use).

2. At Oblast level the introduction of GIS/MIS technology has proceeded rapidly only in GosNPCZem (who now have an advanced set-up covering land resources and property cadastres). Other agencies could greatly benefit from GIS/MIS (and links to GPS and digital field recorders), most notably the three agencies dealing with irrigation and water issues (OblVodkHoz, BVO, HME). Links to some of the coverages currently held by GosNPCZem would be very useful, for at least the respective parts of the geographic areas of interest to these other agencies.

Associated with the introduction of new technology is a need to consider changes to work methodology both in the field and also in the laboratory and office. In many cases work methodology has been inherited from the Soviet period, and cost effectiveness of this methodology has not always been fully questioned. Also Soviet methodology was established in the era immediately prior to computerisation. Incorporation of GIS/MIS and associated remote sensing techniques and automated field procedures may greatly improve work productivity, cost effectiveness, and precision of information.

GIS/MIS on-the-job training specifically targeted to SKO applications has been the major limiting factor to successful GIS development in the Oblast, and major attention needs to be focussed on this for the future.

3. The Oblast EMIMS Subsystem (and the Project) has been based in the Akimat, and that has potential long-term advantages with respect to use of information on land and water degradation for future planning and implementation of rehabilitation activities. Downstream application of GIS/MIS work at Akimat level is enormous: work could usefully be applied to agricultural extension and advisory services with a heavy focus on soil conservation, wind-break belts and firewood plantation (replacing burning of manure which would be better applied to the land), and other aspects of sustainable land use; irrigation and drainage rehabilitation undertaken though integrated watershed management; agricultural credit facilities and land administration and property collateral; structural planning and land zoning; re-orientation of Government subsidies towards supporting good land and environmental management rather than agricultural support subsidies; integration of National and oblast-level economic planning with sectoral planning and land use (structural) planning, etc.

The Sub-system equally could have been based at GosNPCZem: that would have had advantages in terms of immediate access to information and use of existing GIS resources, but might not have been so advantageous in long-term applications of the work. Government could consider boosting resources on GIS/MIS development at oblast and rayon level to be under one roof: i.e. GosNPCZem and MoEP would have access to common resources and data at these levels, and effectively work in the same office. There are many examples from other countries where technical staff from different Ministries work together well at Provincial (Oblast) and District (Rayon) level in well-funded ‘resource centres' equipped with IT and particularly GIS/MIS facilities. (By contrast equivalent staff do not work so well together at National level, where inter-Ministerial rivalry is commonly more problematic).

4. The three mid-level technical staff members appointed to run the SKO Sub-system and acquire data were very hardworking and conscientious. Together they had work experience from four of the key partner agencies and covered very well the respective subject areas. This model is clearly working well (although senior supervision time is a limiting factor) and this model should be extended to other oblasts.

5. There is much interest from farmer's groups in the practical application of the SKO Subsystem at farm level, and particularly the dissemination of data on soil fertility, fertiliser requirements, potential cropping information, and in securing potential funding for land improvement (e.g. soil conservation) activities. There are also many other areas of interest but these are somewhat outside the scope of an information system on land and environment.

6. The major problem faced by the Project has been lack of free access to information from many of the partner agencies. Existing (historic) data is viewed as the personal property of the agency holding the data and is available to outside agencies or Government offices (even under the same Ministry) only at the highest possible price. The consultants have spend an inordinate amount of time chasing data, and then paying out of project funds a high price for a relatively small amount of 'real data'. The Consultants consider that Clause 28 of their TOR / contract specifying access to data has not been met and there could have thus been grounds for terminating the contract. It is strongly recommended that the Government of Kazakhstan sort out this problem, otherwise development of systems such as EMIMS will be highly constrained and Kazakhstan will not be able to meet expectations of CACILM and other multi-national programs. It should be noted that in most countries historical data is either free of charge or available at nominal cost, at least for other offices and agencies within the public sector.

7. Splitting the current project's activities between three centres (SKO / Almaty / Shymkent) has proved to be very problematic, particularly for such short consultancy inputs: any future activity should be based from one centre (ideally the capital city of each respective oblast);

8. The project has lacked a long-term input by a senior Government counterpart resident at the project location, and this has been a further major constraint. The Deputy Team Leader who should have continued activities whilst the team leader was out of the country (i.e. for 9 of the elapsed 14months of the project) was not familiar with GIS/MIS nor indeed familiar with any computer software, and the GIS/MIS/IT inputs carried out by the local consultants have been undertaken by two junior to mid-level staff who have been able to do only short intermittent inputs. These have been major constraints.

9. However, an important further constraint to the work has been the very short inputs of the expatriate staff, particularly given the very heavy schedule for workshops and reporting, leaving relatively little time for undertaking the essential technical work. (Workshops should have been the responsibility of the partner agencies, but these were not prepared for such work: the organisation and technical content of the workshops then fell completely to the consultants.) The problem has been made worse by having a large number of local consultancy staff to direct and supervise (13 in total, including key CSPC head office staff and three recently-appointed staff to the Shymkent office), many of whom have not had international consultancy teamwork experience and all of whom have been bedevilled by problems of lack of access to information. Lack of consultancy time for the expatriate team, particularly for the Team Leader who has had responsibility for the heavy reporting and workshop schedule, has been extremely limiting considering the scope of the tasks envisaged. All the key staff should have been on long-term contracts!

4.1.2 Application of the lessons to future project development

The existing project has had more than a fair share of problems due to size of expectations in relation to length of senior consultants' inputs. Any future project development should recognise the urgent need for long-term expertise. This has been built into the costed proposals given below. Thus, considering the long term objectives and specific requirements of the project:

- a senior technical staff member should have a long-term (2-year) posting in each respective oblast to set up the oblast sub-system. Ideally, that staff member would be from IAC, Astana, seconded to the oblast akimat for the 2-year period: alternatively, a suitably qualified local consultant on a long-term basis could fill the post. In either case, it would be essential for the individual to be based in the capital city of the respective oblast, but with around 3 annual trips scheduled to Head Office, Astana for necessary technical liaison.
- inter-agency cooperation and sharing of primary data still remain key limiting factors to the success of the Kazakhstan EMIMS and much work still needs to be done to alleviate these constraints. The project has done what it can to build good working relationships with the partner agencies and it is important that these continue in the future so that mutually beneficial partnerships continue to develop. This institutional development, however, is time-consuming, and allowances must be made for this.
- if ADB or other internationally-funded agencies show continuing interest in these activities, there is a strong case for a long-term externally-financed TA to assist in further development work on the system. Part of this TA's brief would be to promote inter-agency cooperation and result-focussed institution building at both oblast and national levels. Another part would be on workshop and training activities, both in Kazakhstan and, using the Kazak experience, in the other CACILM countries. A further part would be in national and international reporting on activities which would begin to cover, in the first few years, several oblasts, developments in IAC (Astana), technical liaison with other Ministries and agencies, and work on the interface between the information system and policy development on land and environment.

4.2 Proposals for Future Work

4.2.1 Background

Tentative proposals for future development of the EMIMS system were outlined in the Mid-Term Report and further elaborated and discussed in the 4th Workshop Presentation on 23rd October, 2007. These proposals are presented under three main headings:

- what needs to be done in Shymkent with the SKO Subsystem in the six month and 24 month periods following scheduled close of Project activities in November / December, 2007;
- what needs to be done mainly at IAC-Astana but also with fieldwork periods in Shymkent in absorbing the SKO system and data and setting the framework for the replication of this subsystem throughout the other 13 oblasts of the country;
- what needs to be done for the routine replication of this work among these other oblasts (both in those oblasts and also at IAC-Astana).

4.2.2 Continuing work at the SKO level with the existing SKO subsystem and staff: immediate tasks

The project has sought to set up a workable and useful system using at least a reasonable sample of real data from the SKO. Problems of data availability and cost have meant this has become a very major task, much more time-consuming than originally envisaged. Contingency money was requested to support partner agencies' activities and to acquire more data in order that the system is more useful and workable and covers a larger geographic area. This contingency money would have been spent over the period July-early December, but late approval has put paid to many of these intended activities (see **Table 4.1** of Mid-Term Report).

However, in spite of these operational difficulties, much work has been done and continues to be done. Specific immediate work tasks for SKO Subsystem staff are the following:

1. 1:200.000 coverages from IAC. These coverages have only recently been received by the project and are available as separate (individual Mapsheet) coverages. They now need to be amalgamated and added as key basemap layers to the Subsystem, for use at both SKO-level and individual rayon level. They represent similar material to what the project already has at 1:1million level, but at a scale level very much more detailed.

2. humus content coverage for Karamurt 1:10.000. In a similar format to the existing map coverage on Bonitet ratings, a map coverage on soil humus (or organic-carbon) contents needs to be constructed, with classes as follows (for the 0-50cm layer): <0,5%, 0,5-0,75%, 0,75-1,0%; 1,0-1,25%; 1,25-1,5% etc up to 3%, then all values over 3%. Soil mapping units need to be shaded according to these classes, with blue colours denoted the highest figures, then green, yellow, orange, and red then denoted the lowest figures. This work will then set the format for the definitive work which needs to be extended to the other 28 Selskiy Okrugs, and this will give a very precise calculation of the soil organic-carbon status at detailed (SO) level.

3. 1:300.000 soils map. The original legends for this map are categorically very complex and very difficult to appreciate. CSPC staff (Faya) has usefully simplified the numbering system (two sets of numbering running from 1 to 60-odd and 1-80-odd respectively) and linked this with the existing legend, which has been translated into English. All of this data now needs to be converted into Excel files, and added as attribute data to the digitised soil map. Links from this need to be made to the profile data (see **Annex C**) and particularly the important information covering soil humus percentages in surface horizon materials, soil organic matter stocks, rootable depths, and depths to carbonate concretion layers.

4. Kolkhoz / Sovkhoz names, and links with old and new S.O. names (& locations on GIS coverages). This is very important as original survey work (period 1955-1990) was done at a detailed or semi-detailed level on the basis of the various kolkhozes and sovkhozes, many of which changed name during this period as areas were split, amalgamated, or the various names fell into, or out of, fashion. The project has attempted to correlate the progression of these names with specific locations on the ground (hence geographic coordinates of these centres) and thence the present-day selskiy okrugs (SOs). This work needs to continue, and a definitive listing needs to be compiled. On this basis the changes of bonitet rating from the original surveys (1960s) to the recent surveys (post-2000) can be appreciated.

5. Bibliography List. Further additions to the annotated bibliography (**Annex A**) should be undertaken in both Russian and in English, and follow the format already established.

6. Selskiy Okrug Bonitet Survey reports. The project now possesses copies of 29 of these reports (hard copy) which follow the same format as that for the Karamurt SO, the material of which is reviewed in **Annex B**. The humus data now needs to be entered onto a new Excel file (file 1) – name:(SOname)_humus ; fields: sample number, depth (0-50), humus%.

A second file (file2) needs to be made for the chemical analysis data for the few samples where these are available. A third file (file3) needs to be made for the soil mechanical analysis (sand, silt, clay etc)

4.2.3 Continuing work at the SKO level with the existing SKO subsystem and staff: future tasks

Continuation with activities started by the project following methodology outlined in Section 5 of the Guidelines (specifically Boxes 1-6) need to be undertaken so that a greater proportion of the SKO is included in the respective GIS coverages. On-screen digitisation of scanned map data, subsequent overlay operations with this data, and entry of point data covering soil and water analysis would all form part of this work. A further six-months support (Dec07-May08) had thus been costed for (originally as a part of the Contingency Budget) to cover these activities using the services of the current three technical staff.

An additional 18months work is envisaged for system development at SKO level. It would be envisaged that the three current technical staff members would continue with an extension of their present contracts (but under separate financing) for this period. In addition one senior technical staff member would be appointed from IAC-Astana for this period. (Alternatively, a staff member from an equivalent agency (perhaps GosNPCZem), or an independent local consultant working on a long-term basis could be used). That person would take charge of further development work on the system, and should be prepared to continue with similar work in other oblasts after work at SKO level has been completed. This has been costed at current long-term local consultancy rates, with further sums to cover accommodation / per diems, liaison visits to Astana (3 per year), and local transport and office expenses.

Specific activities envisaged for this period (total 24 months) include the following:

i. **Box 1**: Cartographic output (similar to that already achieved) covering SO crop areas for 2006 (single pie charts) and comparisons with 2005 (double pies); irrigation statistics (rayon level) for 2005, '06 and '07 (when these are available), and multiple pie-chart comparisons between different years; charts in similar format to reflect production and yields; study of individual farm performances in relation to average data for respective SO or rayon and reasons for any differences; comparisons with 2005.

ii. **Box 2:** Economic spreadsheet data needs to be established for other crops; yield data and cost data from the different rayons and SOs need to be applied; updated data required to reflect latest price figures (for both 2006 and 2007 harvests); updated figures for costing of mobile piping and pumps for supplementary sprinkler irrigation, and for drip irrigation equipment;

iii. **Box 3**: Aggregated yield data at SO level to cover all crops and land cover types year by year; total DM figures to be synthesised from this, and thence total organic-C production; incorporation of figures on rainfall and actual evapotranspiration year by year (see Annex E, Guidelines); assessment of organic-C stocks represented by vegetation; further range survey data updated to present, following format to that already presented in Annex G of Guidelines;

iv. **Box 4**: Water analysis data and application to water quality spreadsheet to point data represented by water analysis sampling points at the most critical time of the year (late summer); soil salinity mapping of HME for the worst affected areas (i.e. low-lying irrigated areas in Syr Darya lower floodplain); mapping of areas of alkalinity from HME and GosNPCZem;

v. **Box 5**: Further sprinkler infiltration measurement data to be obtained for drier areas (<400mm MAR) including erosion (upland) positions as well as alluvial / coluvial lands and pasture/range vegetation as well as cultivated areas; automatic slope mapping from detailed detailed topographic contour maps (if/when these are made available) or from DEMs (again questions of availability); Erosion hotspot mapping (from GoogleEarth, from data obtained from rayon and SO administrations).

vi. **Box 6**: Bonitet mapping at SO level (digital data available for 3 additional SOs and methodology developed for Karamurt should be applied here) and comparisons should be made with older (1960s) data; other SOs need digitising from paper maps (work in conjunction with GosNPCZem); humus (organic-C-content) mapping at SO level; Bonitet assessments for mapping units on 300.000 scale map; C-content assessment on 300.000 scale map. Further refinement of C-stocks estimates (refining data presented in **Annex C**, Section 14).

vii. **Basemap coverages**: completion of amalgamation of the 200.000 topo sheet coverages to be accessible at SKO level, and at the level of individual rayons; linked attribute data to cover population centres (down to hamlet level) with updated population statistics; hydrological data to cover individual streams, irrigation canals and drainage canals, and linked data to cover individual catchments and subcatchments; road and access track data (essentially all motorable roads);

viii. Completion of definitive map coverages of **SO and rayon boundaries**;

ix. Completion of digitisation of **rangeland mapping** from 1:200.000 rayon-level maps, and 1:25.000 or 1:50.000 SO maps (see methodology developed in **Guidelines Annex G**).

x. **GE imagery captured at 1:65.000 scale**: georeferenced and added as a 'basemap' layer to the GIS; coverage for entire SKO; (Accessible at SKO level and at the level of individual rayons). Land cover mapping undertaken on the basis of this GE imagery and with limited ground truthing (say on a trial basis on one rayon).

xi. **GE imagery captured at 1:10.000 scale**: georeferenced and added as a 'basemap' layer to the GIS for those specific SOs where 100% coverage is obtained; Land cover mapping undertaken on the basis of this GE imagery (and with the 1:65.000 GE imagery from neighbouring areas) and with limited ground truthing (say on a trial basis on 1 SO).

xii. Further development of **Environmental Audit** methodology following work already undertaken on 6 enterprises and presented in **Guidelines, Annex H**. In particular, linking this work with detailed mapping from 1:10.000 Google Earth coverages in GIS.

xiii. Work with Selection Genetic Centre on Arid Plants on **nutrient characteristics of rangeland** at different times of the year, and measurements also on crop residues and alternative feeds, plus costing of these feeds. Updating of range feed optimisation spreadsheets, as presented in **Guidelines Annex D.4**.

xiv. Further work with GosNPCZem on **soil organic-C status** in relation to land management changes; note necessity for deeper sampling (0-50cm insufficient);

xv. Incorporation of **farm database information on 'model farms'** within the SKO and reporting and publicity on developments within these farms;

xvi. Development of **website** to make available all relevant materials to the general public.

Table 4.1: KAZAKHSTAN EMIMS: Preliminary Budgets for Continued Project Activities:

		Nos.	Rate($)	Total($)	TOTAL($)
A1: Continuing Project Development in SKO (18months)					**141300**
1	Senior technical consultant (1) (ex-IAC or equiv.) (months):	18	900	16200,00	
2	Technical team, SKO (3) (months):	18	1400	25200,00	
3	Shymkent per diems, Snr Tech Consultant (months):	18	1500	27000,00	
4	Shymkent-Astana return air-fares (5)	5	300	1500,00	
5	Astana per diems (days)	10	100	1000,00	
6	Final SKO workshop: 40 staff:local costs	40	25	1000,00	
7	Final SKO workshop: 10 staff:airfares / perdiems	10	500	5000,00	
8	Local transport / taxi: trips:	40	100	4000,00	
9	Office expenses, minor publications (months):	18	300	5400,00	
10	GosNPCZem: payment for data			35000,00	
11	KAZHYDROMET: payment for data			10000,00	
12	HME/OblVodkHoz/BVO: financial support			10000,00	
13	Other partner agencies, (incl.rangeland surveys)			20000,00	
A2: Routine Project Activites (after Development Stage) (12 mo)					**22150**
1	Technical team, SKO (3) (months):	12	1400	16800,00	
2	IAC, Astana supervision: airfares	3	300	900,00	
3	IAC, Astana supervision: perdiems (days)	10	65	650,00	
4	Local transport / taxi: trips:	20	100	2000,00	
5	Office expenses, minor publications (months):	12	150	1800,00	
B: IAC, Astana Support (18 months activity: SKO & Other Oblasts)					**19665**
1	Senior technical consultant (1) (ex-IAC or equiv.) (months):	18	900	16200,00	
2	Local Oblast per diems, Snr Tech Consultant (days)	21	65	1365,00	
3	Local Oblast-Astana return air-fares (7)	7	300	2100,00	
C: Other Oblasts' Subsystem Devmt.(24 months activity)					**260600**
1	Senior technical consultant (1) (ex-IAC or equiv.) (months):	24	900	21600,00	
2	Technical team, ex-local Oblast (3) (months):	24	1400	33600,00	
3	Local Oblast per diems, Snr Tech Consultant (months):	24	1500	36000,00	
4	Local Oblast-Astana return air-fares (7)	7	300	2100,00	
5	Astana per diems (days)	21	100	2100,00	
6	Local workshops (3): x40 staff:local costs	120	25	3000,00	
7	Local workshops (3): x10 staff:airfares / perdiems	30	500	15000,00	
8	Local transport / taxi: trips:	60	100	6000,00	
9	Office expenses, minor publications (months):	24	300	7200,00	
10	GosNPCZem: payment for data			50000,00	
11	KAZHYDROMET: payment for data			15000,00	
12	HME/OblVodkHoz/BVO: financial support			15000,00	
13	Other partner agencies, financial support (incl.rangeland surveys)			20000,00	
14	Study tours: 10 staff: airfares & perdiems	10	500	5000,00	
15	Equipment: hardware (as per SKO)	1	10000	10000,00	
16	Equipment: software (as per SKO)	1	19000	19000,00	

Costed separately are the current costs for data acquisition from the partner agencies, assuming that the agencies still insist on charging for this information. However, it would be expected that Government would seek to limit the cost for this historic data, and / or provide money for future development work for each of these agencies (e.g. giving further support to the excellent soils and bonitet reassessment survey work being done by GosNPCZem at SO level in exchange for data provision to the SKO Subsystem). Total costs for this, and for other parts of the proposed system, are given in **Table 4.1(A).**

It would be expected that the SKO Subsystem would become fully operational in all its functions at the four different levels within a 2-year period from close of present project – i.e. by early December, 2009. However, as from the present, information would be available as it is entered onto the system, area by area.

4.2.4 Work at National level in absorbing the SKO system and data and setting the framework for the replication of this subsystem throughout the other 13 oblasts of the country

A staff member should be appointed at IAC (Astana) to take charge and coordinate oblast subsystem activities. That person would be based in Astana but would have short visits to the different oblasts to have overall supervision of the program, undertake the necessary liaison with the key partner agencies, and attend the oblast workshops. A key task here would be to ensure that the program follows common lines in each of the oblasts while allowing a certain independence for individual oblasts to include features which are unique, or are of special importance, to that individual oblast or region. It is important to realise that each of Kazakhstan's oblasts cover an area of land of the same size as many moderate or even large countries of western Europe, and thus a certain amount of individuality between the different oblasts must be expected. Liaising with the senior officers from each of the oblasts (mainly in Astana, but also in the oblasts in question) would be important task for this person.

It is hoped that this individual would be a permanent staff member of IAC of considerable seniority and length of service. Because of this, the normal staff cost element has not been included, although expected travel costs, per diems etc have been considered. An initial task for this individual would be to oversee continuing activities in the SKO and to ensure that the SKO data is fully replicated on the head office system in Astana. Costing for these activities is given in **Table 4.1(B)**.

4.2.5 The routine replication of this work among these other oblasts.

Routine replication of work among each of the other oblasts should be viewed as 2 years' work following the above model. Timings and costings as in Section 4.3.2 would also apply. Three workshops would be proposed to discuss project activities among the local partner agencies and other stakeholders at oblast level, and these would be scheduled in Month 2, Month 8 and Month 24 of activities in each oblast.

A study tour would be organised for the representatives of the key partner agencies of each oblast to view developments in the initial trail oblast (SKO).

As per SKO, three local technical staff would be recruited to work on each of the oblast subsystems for the 2-year period. A senior technical staff member from IAC or from a local consultancy firm would be appointed to head the local unit and be resident in the local oblast for the same two-year period.

Proposed phasing of work should be as follows:

- Years 1 (part) and 2: continued activities in SKO to be run as trial Oblast;
- Year 2 and 3: activities run for 2nd Oblast
- Years 3 and 4: activities to be run for 3rd and 4th Oblast in contrasting areas of the country;
- Years 5 and 6: activities to be expanded to 4 further oblasts (nos. 5 to 8);
- Years 6 and 7: activities to be further expanded to cover 6 reaming oblasts.

Tentative costing for these activities, on a per-Oblast basis, is given in **Table 4.1(C)**.

Table 4.2 (Cont) : KAZAKHSTAN EMIMS: Preliminary Budgets for Continued Project Activities:

CALCULATION OF TOTAL COSTS:

1: Development Costs (spread over 7-year project period)		
12*C + A1:	3268500,00	
2: Annual routine costs: within 7-year project period (19 Oblast years)	420850,00	
Thus total costs within 7-year project period ($)		3689350
(SAY)		**$3.700.000**
3: Annual routine costs: (entire country: after project period)		
12*A2 + B:	307615,00	
(SAY)		**$308.000**

Remarks:
(1) Data payment/financial support for the Partner Agencies in each Oblast totals $100.000 out of total Oblast costs of $260.000
(2) Software costs for ESRI ArcGIS costed on individual licenses: reduction may be possible for multi-user licenses.
(3) Senior technical consultant (to head Oblast Unit for development period) costed at Long-Term local consultancy rate.
(4) Senior technical consultant assumed to be from outside oblast and will thus need accommodation/per diem.
(5) Astana-based officer costed at Senior technical consultant's LT local consultancy rate
(6) Study tour planned for 10 staff from each oblast to visit pilot oblast (SKO)
(7) 3 local workshops planned for each oblast: months 2, 8 and 24

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5 KAZAKHSTAN EMIMS: Summary and Conclusions on Major Findings and Outputs of Project

Synthesising the work presented in this report and the accompanying Guidelines, together with data presented in the four project workshops and the data now held on the SKO Subsystem, the following summarises the conclusions on the major findings and outputs of the Project:

1. **Institutional:** to act as a pilot project for the *Kazakhstan Environmental Monitoring and Information Management System for Sustainable Land Use* the self-contained **SKO Subsystem** was set up and housed in an office in the **SKO Akimat Ministry of Natural Resources and Nature Protection, Shymkent**. The System was centred on ESRI ArcGIS 9.2 and associated database software (MS Excel / Access) and designed to run on stand-alone PCs. Local staff were recruited and basic on-the-job training given to these staff.

2. The SKO Subsystem provides for Information Flows to and from some **14 Partner Agencies and Offices** (see **Guidelines Figure 1**), and is controlled by a committee chaired by the Deputy Akim. Most of the partner agencies are very interested in this GIS/MIS technology (and associated activities and training involving their staff). The partner agencies are also beginning to be more open about information flows, and making their information available for project use, these factors being a major constraint at the start of the project. In addition, **Farmers' Organisations** as well as local Government staff are most interested in the many practical applications of the work as well as the information itself.

3. The major **problems of degradation of land and water resources** were inspected in the field in the SKO by project staff, and further studied by comparisons with the excellent and detailed *Google Earth* imagery which is available free of charge over the internet. Problems of degradation were listed, studied and discussed under six major categories: rangeland (steppe); rainfed agriculture; irrigated agriculture; basin and watershed management issues; mining and metal processing; and other industrial and domestic source contamination of water courses (see **Guidelines, Section 3**). *Google Earth* imagery downloads were made for all areas in the more-densely populated south-eastern half of SKO. i.e. south of N 44° 30' and east of E 87°. One third of this area was captured at very detailed scale (1:10.000), the remaining areas at semi-detailed scale (1:65.000). The semi-detailed coverage, although lacking in overall resolution, had excellent clarity and spectral resolution, factors which facilitated excellent differentiation of crops and land cover types. The Digital Elevation Models (DEMs) also accessible under *Google Earth* enabled 3-dimesional landscape models to be constructed facilitating appreciation of environmental problems (e.g. gulley erosion).

4. **Indicators of degradation** of land and water resources were reviewed from a wide range of available literature on related projects (see review), were then analysed, and the most important ones were listed, together with relevant parameters, under major indicator groupings. These were then discussed with key stakeholders at international, national and SKO levels, and were further refined (see 1-page summary lists for land and water respectively, **Guidelines Tables 2 and 3**).

5. The **SKO EMIMS Sub-System Design** was further developed, centred on **ArcGIS9.2 and External Tools** (see **Guidelines Figures 2 and 3**). Six main groupings of Indicators of land and water degradation were differentiated (see **6 'boxes' in Section 5 of the *Guidelines for EMIMS Subsystem Design*** which accompanies this report) and procedures were developed to provide information on indicators and specific parameters in each of these groupings.

6. The SKO Sub-System has incorporated much **historic and baseline data** from the Soviet period, as well as **current data**. This has enabled interesting comparisons to be made over the last 15-20 years. Data of Soviet times was mostly done to high technical standards and should be preserved at all levels (farm enterprise level to national Level). Most notable has been the following: (items 7-13 below)

7. Compilation of a **Database of Sovkhozes / Kolkhozes** (old and new names) related to the 181 current **Selskiy Okrugs (SOs)** ('Sub-Districts') and rayons (old and new names), and geo-referencing of all this data. Compilation of bonitet assessment ratings for irrigated and rainfed lands related to this at different periods since the 1960s.

8. **Rangeland (steppe) mapping** at enterprise and at rayon level (both historic and new data); methodology of on-screen digitising techniques and use of 'clip functions' in GIS developed to work out range productivity for any given area; basic quantitative statistics on standing vegetation dry matter (DM) stocks (and thence C stocks); and seasonal and annual productivity in terms of fodder units and digestible protein. (See **Guidelines, Annex G**);

9. A review of **rangeland statistics over the period 1990-2000** was undertaken in relation to rainfall and temperature records and animal numbers / grazing pressure. It is interesting here to note that:
(i) rainfall increased over the period 1930-1960; thereafter it has shown a steady and marked decline;
(ii) range productivity is positively related to season rainfall (Oct-Sept) and also positively related to temperatures in early spring (March, April); however, it is negatively correlated with temperatures in early summer (May, June);
(iii) rangeland Water Use Efficiency (WUE) (i.e. range productivity / mm rainfall) showed a steady increase over period 1990-2000 in spite of an overall fall in rainfall. Higher WUE correlates with a fall in animal (particularly sheep) numbers over the period due to economic / restructuring problems in the immediate post-Soviet period.

Good range management and control of animal numbers is thus essential in arresting rangeland degradation. Currently animal numbers are increasing, and there are many indications of increasing degradation in range areas near settlements, and also near some watering points. Conversely, in some locations rangeland appears to be underutilised. Further GIS-based work on these aspects needs to be undertaken, to improve both the environmental management of the rangeland, and the socio-economic status of the livestock owners.

10. A **rangeland (steppe) / alternative feed optimisation spreadsheet** and associated data and procedures to improve nutrition of animals has been introduced to improve range management and nutrition of animals by optimising use of alternative feedstuffs (many of these feedstuffs being under-valued crop residues) (**Guidelines, Annex D.4**.).

11. **Soils and bonitet assessment mapping and data** were obtained at SO (1:10.000) and SKO level (1:300.000). Again both historic (1960s) and new data (after 2000) is being obtained. The GosNPCZem program of re-survey of soil humus and bonitet reassessment at SO level deserves further support as work is fundamental to appreciation of land quality status (and conversely any problem of land degradation) and soil carbon stocks. Interesting changes in humus contents and bonitet ratings can be seen over a 40-year period can be seen from these detailed surveys. Hard-copy data from 29 SOs were obtained from different rayons, and soft-copy (shape) files were obtained from 4 SOs in Sairam rayon and analysed by the project (**Final Report, Annex B**).

12. **Irrigation statistics** information at rayon level, for farms, enterprises, and small plots, was obtained and covered:
- areas irrigated and cultivated under different crops (ha);
- total agricultural production (tonnes) for each crop;
- yields (centners / ha) for each crop.

Main crop groupings are (generally in decreasing order of value): vineyards; berries and fruits; melons and gourds; vegetables; potatoes; oilseeds; fodder maize; cereals; other (mainly grass, alfalfa); cotton. Data was obtained and analysed for 1987 and 1990 (Soviet period); 1995 and 1997 (downturn in economy following post-Soviet reconstruction); 2004 (pronounced upturn and most recent complete year). Representation of comparisons between 1987 and 2004 were made as concentric pie-charts with dramatic differences being shown between different years and between different rayons (**Guidelines, Fig.5; Report Annex G**).

Overall, irrigated land use changes over the period 1987 to 2004 are the following:
- marked increase (and pronounced over-dependence) in cotton in Maktaraal, Shardara, Arys, Otyrar, Turkestan, and Ordabasy rayons;
- marked decline in fodder maize in all areas;
- marked expansion of cereals in Sozak, Baidebek, Siaram, Tulkibas, Tolebi, and Saryagash rayons;

- marked decline of cereals (at the expense of cotton) in Shardara, Arys, Ordabasy, Turkestan rayons;
- irrigated cropping in main rainfed areas shows a much better balance between crops, but a tendency for specialisation: berries and fruits in Tolebi and Tulkibas; vegetables in Sairam, Kazigurt, Baidebek, Saryagash; oilseeds in Kazigurt and Ordabasy.

13. **Total cultivated areas statistics** at Selskiy Okrug level again included data for farms, enterprises and small plots on: areas (ha) cultivated under different crops; total production; yields (centners/ha). Data was obtained and analysed for 2005 (first year available under SO format) and 2006. Main crop groupings are: vineyards, berries and fruits, melons and gourds, vegetables, potatoes, sunflower, safflower, cereals, others (including planted grass, alfalfa, and also cotton). Deduction from total SO area gave uncultivated areas, enabling a total-SO land use breakdown. Statistics were viewed in relation to mean annual rainfall, elevation zones, and to population and marked specialisation of some SO in particular land uses were seen, e.g. main concentration of vineyards and vegetables in several SOs (see **Guidelines, Fig.4**).

14. A review of **soils / land units** of the SKO was undertaken. A GIS overlay of precipitation zones vs elevation zones was undertaken and relationships were investigated with soil chemical and physical properties and soil organic-C stocks. Soil analysis data (physical, chemical, fertility) was reviewed for the SKO (**Final Report, Annex C**). Soils were mostly derived from loessial loam parent materials, mostly deep or very deep (>200cm), rich in free carbonates and inherently fertile, with a high available water holding capacity (AWHC), cation exchange capacity, total P and K, and available K. However, N and available P are commonly limiting. Moderate to high pHs (7,5-8,0) may be limiting for trace element uptake for many perennial and horticultural crops, although at the same time these would also reduce uptake of toxic heavy metal pollutants (e.g. Pb, Cd, Zn). Elevation zones (200m – 4000m) and rainfall zones (<150 - >800mm), and variable relative relief are major determinants in soil type, with key properties here being: - humus content (both of A-hor and B-hor materials); depth to moderate carbonate and visible carbonate accumulation layers; surface infiltration rates and subsurface hydraulic conductivities; soil structural stability. Poor surface structural stability, low infiltration rates, and susceptibility to both water and wind erosion are major problems in what otherwise would be good agricultural soils, and these need special measures for sustainable long-term management.

15. Guidelines were finalised on **Environmental Auditing (EA) of Agricultural Enterprises and farms**, based on a review of national legislation and current procedures on environmental audits on industrial enterprises, and current development and reconnaissance work undertaken by the project in six agricultural enterprises in Maktaraal, Sayeram, and Tolebi rayons. A holistic / multi-disciplinary approach is necessary: understanding of farming systems, as well as rural environmental problems, conditions of soils, waters, and socio-economic aspects are all necessary in this work, as is a strong geographic and cartographic focus. A considerable overlap also exists between such EA work and agricultural management consultancy. The commissioning of such work could be dictated by changes of land ownsership at a local level as well as requirements for compliance with international environmental standards. This work also represents the most detailed level on the GIS/MIS (**see Guidelines, Annex H**).

16. **Economic 1-ha Farm Model spreadsheets** were further developed to generate key socio-economic parameters and to work out Internal Rates of Return for long-term agricultural / rural investments. Spreadsheets work in both Tenge (operational sheet) and US$ (automatic conversion). Key parameters are total revenue, cost of production, cost of labour and supervision, total variable costs, financing and fixed costs, net return before labour, net return after labour, return per labour hour. Economics to a large extent will dictate future development and possible future environmental problems, and hence economic approaches and appraisals are essential. The model currently demonstrates the high costs of machinery and capital equipment for many farming enterprises, in large part due to the very high real interest rates having to be paid for loans for such equipment (**see Guidelines, Annex D.1**).

17. **Salinity problems of soils and shallow groundwaters** are more related to poor drainage management than to massive irrigation water quality problems (overall, average irrigation water quality is good by international standards: moderate salinity levels; low AdjSAR levels). Lack of workable institutions at irrigation/drainage group level is seen as a major constraint. High soil and groundwater salinity levels are further aggravating the problems of cotton monoculture: cotton is one of the few crops that is relatively tolerant of high salinities (by contrast, excellent rotation crops such as

alfalfa and clover are very sensitive to salinity). Problems also occur at international level (i.e. excessive water flows on Syr Darya in winter and early spring; too low flows in late summer). An irrigation/drainage water quality assessment interactive spreadsheet following FAO water quality criteria forms part of the external tools of the SKO subsystem (**Guidelines, Annex D.2**).

19. **Environmental Problems of Agriculture** were analysed and include:
- major problems of cotton monoculture and lack of drainage infrastructure in Maktaraal rayon;
- problems (in all areas) of inadequate farm machinery and high real interest rates on loans;
- lack of contour cultivation and simple in-field soil conservation measures;
- lack of windbreaks (excessive evapotranspiration in May and June severely depresses yields for many crops);
- inadequate organic manure applications and crop rotations;
- inadequate use being made of compost, sewerage sludge, town organic wastes.

20. **Sprinkler infiltration rates** provide a good indicator of land degradation. Amounts infiltrated vary across rainfed agricultural areas between 4 and 46mm/hour. Pasture sites showed much higher rates than cultivated sites (averages of 23mm/hr and 8,5mm/hr respectively). Most critically, many cultivated sites had infiltration rates below the rates of high-intensity rainfall: these sites represent an appreciable erosion hazard for cultivated land. Sprinkler infiltration measurements need to be extended over wider areas and to be used routinely as a direct key indicator for land degradation. (see **Guidelines, Annex F**).

21. **Evapotranspiration calculation** (FAO CROPWAT) and **dry-period analysis** of 3 rainfall stations (Shymkent, Tasaryk, Ryskulov) for 16 years (1991-2006) were made. Actual to potential evapotranpiration ratios reflecting on soil moisture status was plotted on a pentade basis for these stations for the 16 year period graphically showing the variation in drought severity from year to year which correlated well with rainfed cereal yields. Windspeed was a major determinant of high evapotranspiration rates (and hence emphasising an urgent need for installation of windbreaks). Dry autumn periods (soil too dry to cultivate and plant winter wheat) and dry spring periods (time of ear initiation for cereals) were major factors in determining low cereal yields. Cereal yield was closely correlated with actual evapotranspiration and available moisture in the profile and particularly the A-horizon at the ear-initiation period. Supplementary irrigation needs to be considered (use of mobile pipes and sprinkler equipment) as marginal water use efficiencies under SKO conditions are likely to be extremely high and very cost-effective. (see Guidelines, **Annex E**).

22. International, national and oblast-level work on **soil organic matter (humus) status and soil-C stocks** were reviewed (**Report, Annotated Bibliography, Annex B; Report, Annex F** and **Report, Annex C**). Local soils' organic-C stocks differ widely, from <2tonnes/ha in some of the driest desert areas at low elevation to 750tonnes/ha for some hydromorphic organic soils occurring at high elevation. Overall, it is estimated that soil-C stocks for the SKO total around 325million tonnes, an average of just under 30tonnes/ha. Soil C is positively related to precipitation, elevation, and negatively related to intensity of cultivation. Large areas of land in the SKO with potential for rainfed and irrigated agriculture show soil carbon stocks of between 20 and 120tonnes/ha. Deep soils, of high free-carbonate status, are mostly responsible for these relatively high figures. (Note: Russian chernozem soils commonly show soil-C stocks of around 460 tonnes C / ha with appreciable organic-C occurring up to 3-m depth.) Routine analysis must be undertaken to greater depths as soil C stocks in deeper subsoils may be important. Good or bad farming practise can commonly make a difference of +0,5 to –0,5 tonnes C/ha/year for soil organic-C status under SKO conditions, and somewhat larger quantities for vegetation stocks (e.g. up to 2,0 tonnes C/ha/yr for good regenerating rangeland in higher rainfall areas. Possibilities for an international system of carbon taxation and carbon credits and implications for SKO agriculture and land use practices were discussed (i.e. Kyoto II and III). At a valuation of carbon at $100/tonne, carbon credits could provide an appreciable incentive to Kazakh farmers and landowners to encourage better environmental practices. However, to be workable, this would require a good system of monitoring (and an extension of the work being done at SO level by GosNPCZem and the SKO Subsystem).

Annex A: Annotated Bibliography

Articles are listed here under the following headings:
- Legal documents including laws and government decrees of the RK
- Guidelines and reports of GosNPCZem
- State Programmes and Donor Projects
- Reports on finalized projects
- Guidelines and reports from LADA
- International Conventions, Agreements, Guidelines and Norms
- Carbon Sequestration and Stocks.

Legal documents including laws and government decrees of the RK

1) Закон об охране окружающей среды от 15 июля 1997 года
Law on the Protection of the Environment of 15 July 1997
The law regulates in general terms the conduct of Environmental Monitoring and the utilization of environmental information (Article 24).

2) Земельный кодекс РК от 20 июня 2003 года;
Land Code of the RK of 20 June 2003
The land code regulates in general terms the conduct of land monitoring and land cadastre.

3) Закон «О недрах и недропользовании» от 27 января 1996 года
Law on mineral resources and their use of 27 January 1996
The law regulates the utilization of mineral resources and provides basic rules for re-cultivation of lands affected by mining activities.

4) Водный кодекс РК от 8 июля 2003 года
Water Code of the RK of 8 July 2003
The water code regulates in general terms the monitoring of water utilization.

5) Закон «Об охране атмосферного воздуха» от 12 марта 2004 года
Law on the protection of the atmosphere of 12 March 2004
The law contains provisions on the monitoring of air pollution related to emissions and general pollution state.

6) Постановление Правительства Республики Казахстан от 27 июня 2001 года № 885 «Об утверждении Правил организации и ведения Единой государственной системы мониторинга окружающей среды и природных ресурсов»;
Decree of the Government of the Republic of Kazakhstan of 27 June 2001 No. 885 "About the approval of the Rules of organization and conduction of the Uniform State System on Monitoring of Environment and Nature Resources"
The rules are attached to the Government decree. They contain goals, objectives and functions of the USEMS, its structure and content, the supervision as well as the organizational and financial functioning of the system.

7) Постановление Правительства Республики Казахстан от 19 сентября 2003 года № 956 «Об утверждении Правил ведения мониторинга земель и пользования его данными в Республике Казахстан»
Decree of the Government of the Republic of Kazakhstan of 19 September 2003 No. 956 "About the approval of the Rules of conduction of the land monitoring system and the use of its data in the Republic of Kazakhstan"
The rules are attached to the Government decree. They determine in general terms the types and levels of land monitoring, frequency, types of work (including organization of the data base), responsibilities and organisational setup, utilized materials and forms of documentations.

8) Постановление Правительства Республики Казахстан от 26 января 2004 года N 85 Об утверждении Правил ведения государственного мониторинга водных объектов, государственного учета вод и их использования

Decree of the Government of the Republic of Kazakhstan of 26 January 2004 No. 85 "About the approval of the Rules of conduction of the state monitoring of water bodies, state inventory of waters and their utilization"
The rules are attached to the Government decree. They determine in general terms all issues related to monitoring of surface and ground water.

9) Приказ Председателя Комитета геологии и охраны недр Министерства энергетики и минеральных ресурсов Республики Казахстан от 9 февраля 2004 года N 21-п Об утверждении "Инструкции по ведению Государственного кадастра участков загрязнения подземных вод Республики Казахстан"
Order of the Head of the Committee for Geology and Protection of Mineral Resources of the Ministry of Energy and Mineral Resources of the Republic of Kazakhstan of 9 February 2004 No. 21-p "About the approval of the Instructions for the conduct of State cadastre of areas of ground water pollution of the Republic of Kazakhstan"
The order concerns instructions for the monitoring of points of local ground water pollution.

10) Постановление Правительства Республики Казахстан 10 января 1996 года № 38 Об утверждении Положения о статусе наблюдательной станции за состоянием природной среды
Decree of the Government of the Republic of Kazakhstan of 10 January 1996 No. 38 "About the approval of the Decree on the status of stations for observation of the conditions of natural environment"

Guidelines and reports of GosNPCZem

1) Государственный комитет РК по земельным отношениям и землеустройству
Научно-методические указания по мониторингу земель Республики Казахстан. Алматы, 1993 г.
State Committee of the Republic of Kazakhstan on Land Relations and Land Use Planning
Scientific-methodical instructions on the monitoring of lands of the Republic of Kazakhstan. Almtaty, 1993. 108 p.
The brochure provides the detailed methodological basis for land monitoring in Kazakhstan, as carried out by the SALRM (that time Goskomzem). It contains detailed instructions and reporting formats for inventory and monitoring of land of various categories and land-use type. Detailed instructions are provided on soils of agricultural lands and on vegetation of natural pastures and hay meadows. Brief instructions are provided on information technology and review and approval of monitoring results. The brochure provides a very good and concise overview.

2) Государственный комитет РК по земельным отношениям и землеустройству
Государственный научно-производственный центр земельных ресурсов и землеустройства
Инструкция по проведению крупномасштабных (1:000 – 1:100000) геоботанических изысканий природных кормовых угодий Республики Казахстан. Алматы, 1995 г. 228 стр.
State Committee of the Republic of Kazakhstan on Land Relations and Land Use Planning
State Scientific Production Centre on Land Resources and Land Use Planning
Instruction for the conduct of large scale (1:1000 – 1:100,000) surveys of natural fodder lands of the Republic of Kazakhstan. Almaty, 1996. 228 pages.
The instruction is approved by the GosKomZem and provides the details on all aspects of the inventory of rangelands and hay meadows. It provides a complete methodological instruction containing the organizational aspects of the work, the details of methodology for preparatory work, field assessment and processing of data, reporting formats and annexes (e.g. re-growth coefficients, fodder, unpalatable, harmful and indicator species, legend symbols, fodder values, classification of fodder land types).

3) Государственный комитет РК по земельным отношениям и землеустройству
Государственный научно-производственный центр земельных ресурсов и землеустройства
Руководство по обработке и анализу результатов мониторинга земель. Алматы, 1996 г.
State Committee of the Republic of Kazakhstan on Land Relations and Land Use Planning
State Scientific Production Centre on Land Resources and Land Use Planning
Manual on processing and analysing of the results of land monitoring. Almaty, 1996.
The manual is based on the state of the art of the mid nineties and thus in most aspects outdated. It provides information how at this time monitoring data have been stored and processed. Thus it can serve as a tool for access to older land monitoring data needed for the analysis of trends.

4) Министерство сельского хозяйства Республики Казахстан
Руководство по информационному обеспечению Мониторинга орошаемых земель. Астана, 1998. 32 стр.
Ministry of Agriculture of the Republic of Kazakhstan
Manual for informational support of the monitoring of irrigated lands. Astana, 1998. 32 pages.
The manual is providing the design of the information management system on monitoring of irrigated arable lands. It includes data base structures, ground water modelling, GIS, reporting formats (input and output), specifications on hard and software. It is in most aspects outdated but can provide useful guidance for the comparative assessment of data collected during recent years. The implementation status needs to be assessed.

5) Государственный комитет РК по земельным отношениям и землеустройству
Методические указания по ведению оперативного мониторинга земель Республики Казахстан. 1995г.
State Committee of the Republic of Kazakhstan on Land Relations and Land Use Planning
Methodical instructions for the conduct of operative land monitoring of the Republic of Kazakhstan. 1995.
The brochure provides a brief instruction on land monitoring at rayon level. Attached is a table format for reporting at rayon level. Outdated.

6) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Инструктивные указания по ведению и стандартизации работ по мониторингу пахотных земель Республики Казахстан на стационарных пунктах наблюдений
Agency of the Republic of Kazakhstan for the Management of Land Resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Instructions on the conduction and standardization of work for monitoring of arable lands of the Republic of Kazakhstan on stationary observation points. Almaty, 2002.
The brochure provides a detailed manual for the conduct of field observations on permanent observation sites. It includes a list of natural agricultural zones of Kazakhstan, based on zones, provinces and districts. A map presenting the zoning is missing. Formats for reporting are attached.

7) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Промежуточные результаты по бюджетной программе 006 «Прикладные научные исследования в области управления земельными ресурсами» за 2004 год
Тема: Принципы формирования системы мониторинга земель в условиях нового земельного строя.
Раздел: Разработка методов тематической обработки космических снимков для решения проблемы ландшафтного мониторинга земель. Астана, 2005 г.
Agency of the Republic of Kazakhstan for the Management of Land Resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Intermediate results of the budget program 006 “Applied scientific research in the field of the management of land resources” for 2004.
Topic: Principles of the formation of a land monitoring system under the conditions of the new land structure.
Section: Elaboration of methods for the thematic processing of satellite images for the solution of issues of landscape land monitoring. Astana, 2005.
Report on the elaboration of methods for land-use planning on village level with the support of satellite imagery (low resolution – NOAA AVHRR, medium resolution – EOS Terra Modis, high resolution – KA Meteor-3 M and IRS). The report refers to arable lands and the conditions of the cultivated crops, assessed on the ground and by remote sensing (e.g. NDVI). It does not provide a full instruction for the application of the tested method.

8) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Промежуточные результаты по бюджетной программе 006 «Прикладные научные исследования в области управления земельными ресурсами» за 2005 год
Тема: Научно-методические обоснования организации территории на основе ландшафтно-экологического подхода. Астана, 2005 г.
Agency of the Republic of Kazakhstan for the Management of Land Resources

State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Intermediate results of the budget program 006 "Applied scientific research in the field of the management of land resources" for 2005.
Topic: Scientific-methodical justifications of territorial division on the basis of the landscape ecology approach. Astana, 2005.
The report provides results of landscape ecological research of pilot areas in Akmola oblast. The research was focusing on the interrelations between natural components and anthropogenic factors in the zone of high-risk arable farming. Spatial and temporal changes of landscape systems and their transformation under agricultural use have been analysed. Land degradation processes as erosion, salinization, pasture degradation and others were determined. The report provides methodological aspects for the conduction of land related environmental monitoring and land-use planning.

9) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Промежуточные результаты по бюджетной программе 006 «Прикладные научные исследования в области управления земельными ресурсами» за 2005 год
Тема: Принципы формирования системы мониторинга земель в условиях нового земельного строя. Астана, 2005 г. 32 стр.
Agency of the Republic of Kazakhstan for the Management of Land Resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Intermediate results of the budget program 006 "Applied scientific research in the field of the management of land resources" for 2005.
Topic: Principles of the formation of a land monitoring system under the conditions of the new land structure. Astana, 2005. 32 pages.
The brochure provides the key results of the elaboration of catalogues for decoding of satellite images for land monitoring. The report describes methods and procedures for the decoding of satellite images of low (AVHRR NOAA, MODIS) and high resolution (IRS PAN and Liss) for determination of agrarian landscape types. The study is based on timelines over several years, e.g. 6 year rows of NDVI. Potentials for desertification assessment on based of NDVI changes are discussed. A list of indicators for land monitoring is proposed which can provide a good basis for the development of the indicator set for the EMIMS.

10) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Промежуточные результаты по бюджетной программе 006 «Прикладные научные исследования в области управления земельными ресурсами» за 2005 год
Тема: НАУЧНОЕ И МЕТОДИЧЕСКОЕ ОБОСНОВАНИЕ СИСТЕМЫ ПЛАТНОГО ЗЕМЛЕПОЛЬЗОВАНИЯ И ЭКОНОМИЧЕСКОГО СТИМУЛИРОВАНИЯ РАЦИОНАЛЬНОГО ИСПОЛЬЗОВАНИЯ И ОХРАНЫ ЗЕМЕЛЬНЫХ РЕСУРСОВ. Астана, 2005 г. 52 стр.
Agency of the Republic of Kazakhstan for the Management of Land Resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Intermediate results of the budget program 006 "Applied scientific research in the field of the management of land resources" for 2005.
Topic: Scientific and methodical justifications of the system of land-use based on payments and the economic stimulation of rational use and protection of land resources. Astana, 2005. 52 pages.
The brochure provides the experience of the land cadastre assessment for linear objects and towns.

11) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Промежуточные результаты по бюджетной программе 006 «Прикладные научные исследования в области управления земельными ресурсами» за 2005 год
Тема: НАУЧНО-МЕТОДИЧЕСКОЕ И ТЕХНОЛОГИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ГОСУДАРСТВЕННОГО ЗЕМЕЛЬНОГО КАДАСТРА. Астана, 2005 г. 41 стр.
Agency of the Republic of Kazakhstan for the management of land resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Intermediate results of the budget program 006 "Applied scientific research in the field of the management of land resources" for 2005.
Topic: Scientific methodical and technological support for the state land cadastre. Astana, 2005. 41 pages.

The report is of intermediary character. The major focus is on the methodological basis of the land cadastre, among them on the improvement of land inventory. It includes in brief terms the inventory of land quality of plots and the determination of production value (bonitet).

12) Агентство РК по управлению земельными ресурсами
Государственный научно-производственный центр земельных ресурсов и землеустройства (ГосНПЦЗем)
Мониторинг земель Республики Казахстан 9Сосотояние и перспективы). Астана, 2005 г. 17 стр.
Agency of the Republic of Kazakhstan for the Management of Land Resources
State Scientific Production Centre on Land Resources and Land Use Planning (GosNPCZem)
Monitoring of the Lands of the Republic of Kazakhstan (Condition and perspectives). Astana, 2005. 17 pages.
The brochure describes in brief and with schemes and illustrations the current system of land monitoring in Kazakhstan including coverage, frequency, observation points, financial support and perspectives. It has been prepared for reporting at the Auditing committee for the control of utilization of the Republic budget.

13) Агентство РК по управлению земельными ресурсами, 2003. Суммарный аналитический отчет о состоянии земель и землепользования в Республики Казахстан в 2002 г. Отчет Агентства РК по управлению земельными ресурсами, Государственного научно-производственный центра земельных ресурсов и землеустройства и Государственного Института Сельскохозяйственного аэрофотогеодезического обследования
Agency of the Republic of Kazakhstan for Land Resources Management, 2003. Summary Analytical Report on Land Condition and Land Use in the Republic of Kazakhstan in 2002. Report by: Agency of the RK for Land Resources Management; State Research and Production Centre for Land Resources and Land Use Planning; State Institute for Agricultural Aero-Photo Geodesic Surveying.
The brochure describes in brief and with schematic maps and illustrations the current system of land monitoring in Kazakhstan including coverage, frequency, observation points, financial support and perspectives. It has been prepared for reporting at the Auditing committee for the control of utilization of the Republic budget.

Chapters cover:
1. Administrative and Territorial Organisation of the RK: this comprises:

National total of:	272.49m ha;	160 rayons;	86 towns;	39 big towns;	189 urban villages;	7176 villages.
SKO total of :	11.72m ha;	12 rayons;	8 towns;	4 big towns;	13 urban villages;	831 villages.

2. Condition of the land and how it is used:
Nationally, 33% of land is classed as agricultural / farming land; 7.9% is settlements; 0.9% is industry / transport; 0.5% reserves, sanitoria, historical sites; 8.6% forest resources; 1.4% water; 47.7% unused. Decline of farming land over the period 1991-2002 was most acute in Kyzyl Orda, and SKO;
Irrigated land: nationally 2.379m ha in 1991, declining to 2.141 in 2002.

Subdivision of 'land fund' (total 272.490m ha): agricultural land:222.619m (87.1%); arable:22.800m (8.4%); permanent grasses:0.123m (0.1%); fallow:5.546m (2.0%); grassland:5.048m (1.8%); pasture:189.017m (69.4%); kitchen gardens:0.085m (0.0%); forest & bushland:14.328m (5.3%); swamps:1.105m (0.4%); water:7.713m (2.8%); river channels:0.136m (0.1%); roads:1.448m (0.5%); parks:0.026m (0.0%); buildings:0.601m (0.2%); derelict land:0.172m (0.1%); other land:24.343m (8.9%).

Changes in agric land from 1991 to 2002 have been as follows (m ha):

Category:	Natl'91	Natl'02	SKO'91	SKO'02
Agric land total:	223.115	222.619		
Arable land:	35.403	22.800	1.190	0.833
Irrigated arable:	1.969	1.441		
Perennial:	0.163	0.123		
Fallow:	0.278	5.546	0.046	0.190
Grassland:	5.106	5.048		
Pasture:	182.164	189.017		9.071
Irrigated Lands:				
Total irrigated:	2.380	2.141	0.496	0.512
Other irrigated:	0.141	0.066		
Arable irrigated:	1.969	1.441		
Perennial crops - irrigated:	0.070	0.081		
Fallow, potential irrign:	0.052	0.423		
Grassland irrigated:	0.023	0.018		
Pasture irrigated:	0.124	0.107		

3. Quality status of land
Suitability of the agricultural land of the Land Fund:

	Agricultural		Arable		Irrigated	
	National	SKO	National	SKO	National	SKO
Total:	222.619	10.268	22.800	0.833	1.441	0.423
Total without –ve chars:	42.750	1.969	14.855	0.410	0.747	0.212
Total suitable:	23.269	0.911	14.092	0.353	0.743	0.212
Gravelly:	46.325	1.083	1.239	0.007	0.168	0.001
Saline:	33.916	2.225	2.108	0.184	0.366	0.173
Alkaline:	61.064	1.010	2.577	0.007	0.041	0.007
Water eroded:	5.010	0.959	0.929	0.224	0.049	0.031
Wind eroded:	25.490	3.113	0.567	0.001	0.012	0.000
Water & wind eroded:	0.199	0.000	0.002	0.000	0	0
Overly wet:	3.126	0.001	0.475	0.001	0.056	0.000
Waterlogged:	0.957	0.002	0.006	0.000	0.003	0.000
Others:	3.780	0.006	0.043	0.000	0	0

4. Effect of human impacts on condition of the land

5. Development of land laws and regulations

6. Land resources management
6.2: Computer-based information system of state land register (cadastre):
In 2002 two subsystems were created: ‘Uniform state land register’ and ‘Land balance’ with software (Oracle 8i and ArcGis8.2) and computers being bought. Two Rayons in Aktyubinskaya Oblast were chosen for pilot projects and the following special digital maps were made:

- cadastre map;
- map of agricultural land;
- soil map;
- forage land map.

Databases were created with relevant parameters, and reference manuals showing operation of the system, codes and computer symbols were created. Experimental work was also undertaken on data transfer from the complexes of Rayons to the Oblast and thence to the National level.

6.4: Land monitoring: (p.115: extract concerning SKO):

In SKO in 1992 work started on establishing a network of key monitoring sites and stationary-ecological stations. Every two years surveillance work on land monitoring is carried out.
These sites are located on the following soil types: subtropical sub-mountain semi-desert zone of common grey soil (irrigated and ? cropland); subtropical desert zone of light grey soil (irrigated cropland); Pamirs-TienShan mountain zone of dark grey soil (non-irrigated cropland); desert grey-brown soil (irrigated cropland).

During the monitoring at the stationary surveillance stations the following was determined:

- desert grey-brown soil zone (irrigated cropland) – the humus content in the arable layer was not observed;
- subtropical desert zone of light grey soil (irrigated cropland) – the humus content was significantly reduced;
- subtropical sub-mountain semi-desert zone of common grey soil (irrigated and ? cropland) and Pamirs-TienShan mountain zone dark grey soil (non-irrigated cropland) – in some part the humus content was reduced.

7. Geodesy and cartography

8. State control of land use, land conservation and compliance with the law

9. Improvement of land laws and regulation of land use.

10. International cooperation.

11. Improvement of state control of land management.

State Programmes and Donor Projects

1) Программа по борьбе с опустыниванием в Республике Казахстан на 2005-2015 годы
State Program of Combating Desertification for 2005-2015
In January of 2005 The Government of Kazakhstan confirmed the Program on Combating Desertification in the Republic of Kazakhstan for 2005-2015. The purpose of the program is the consolidation of efforts of state bodies, private sector and non-governmental organizations to prevent land degradation, to increase its productivity and to conserve biodiversity for achieving the objectives of stable development, enhancing welfare of the population and stabilizing environment. The program is intended as an operational plan for direct implementation.

2) Программа по рациональному использованию земель сельскохозяйственного назначения на 2005-2007 годы
State Programme on the Rational Use of Agricultural Lands 2005-2007
The Program for Rational Use of Agricultural Lands is mainly related to inventory, planning, monitoring and control of land-use. For the realization of the program comparably large state budget resources are planned. The program does not refer to the UNCCD, the NAP and thus does not build links to the Ministry of Environmental Protection and the National CCD Working Group.

3) Национальная Рабочая Группой КБО Республики Казахстан: Инициатива Стран Центральной Азии по Управлению Земельными Ресурсами (ИСЦАУЗР) - Национальная рамочная программа - Республика Казахстан. Проекта 08 Января и 07 февраля 2006
UNCCD National Working Group of the Republic of Kazakhstan: Central Asian Countries Initiative for Land Management (CACILM) - Republic of Kazakhstan - National Programming Framework, Drafts 8 January and 07 February 2006
The document is providing an analytic overview on all land-use related issues in Kazakhstan, analyzes problems and underlying reasons, assesses possible solutions and provides a framework for interventions. The draft as of 8 January 2006 provides more details than the second version.

4) Инициатива Стран Центральной Азии по Управлению Земельными Ресурсами (ИСЦАУЗР): ИСЦАУЗР Рамки Многострановго Партнерства, Документ проекта поддержки, Март 2006.
Central Asian Countries Initiative for Land Management (CACILM): CACILM Multicountry Partnership Framework Support Project Document, March 2006.
The document contains a brief description of the Sustainable Land Management Information System, a component to be implemented by FAO and based on the LADA approach which is briefly described.

….Main Text: 31January, 2006
Report is very broad-ranging, emphasising multi-donor, multi-country, multi-agency approach and very practical final objectives for the project. The most relevant sections with respect to EMIMS include the following:
GEF Alternatives: low-tillage agriculture proposed to stabilise soils, reduce erosion and improve water retention;
Indicators of success include arresting land degradation & improving welfare of those relying on land resources;
p14. SRAP-CD: Sub-regional Action Program Combating Drought
NPFs show 8 goals: i) land management issues, including policy reforms; ii) integrated sustainable land management; …
M&E: Land Degradation and Sustainable Land Management indicators
p16. National Monitoring & Evaluation System: Performance Indicators: Sustainable Land Management & Sustainable Land Management Information Systems; major weakness highlighted in land administration.
p37. Integrated Land Use Planning and Management: adoption of SLM practises based on bio-geographical and community priorities and ‘social profitability’; including rehabilitation of degraded lands.
p60. Sustainable Land Use Management Information Systems (SLMIS) – common set of indicators.
Establishment of a bilingual website;
Projects to be implemented under CACILM umbrella include: Irrigation Ecosystem Management, Kazakhstan; Drylands Management, 03-08; Irrigation & Drainage II.

Reports on finalized projects

Regional Network to Promote Wheat Growing and Seed Production in Central Asia (CIMMYT)

ADB: TA 6155-REG Capacity Building in Environmental Information Management Systems (EIMS) in Central Asia - Environmental Information Management System (EIMS) in the Republic of Kazakhstan Deloitte & HCG Environment: Design Document, Almaty 2006. 58 pages.

In the scope of the project TA 6155-REG: Capacity Building in Environmental Information Management Systems (EIMS) in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan) a framework for information management based on harmonised data handling was developed. One cornerstone of the project was to implement an information management system in 4 countries which can be used for storage of data collected in the national monitoring programmes and which could produce reliable information on the environment required for both national and international environmental management concerns. The aim of the project was therefore to describe the basic elements which need to be implemented in all the countries and to implement basic parts of the system to demonstrate its usefulness and potential.

Consultants worked in association with KAZHYDROMET in Almaty and used to a very large extent the parameters which KAZHYDROMET were covering: atmospheric pollution and most water quality parameters are thus covered well – land degradation and some water parameters relating to irrigation were covered less well.

Detailed notes are as follows:
p7. discusses eventual compatibility with the European Environment Agency (EEA)'s 'Waterbase' (information management system covering water resources) and EEA's indicator-based fact-sheets;

p12. Fig 1.2: Common Data Model;

p13. Map formats, scales and projections discussed, together with GIS software and GPS receivers. Krasovsky spheroid / Pulkovo1942/GCS_Pulkovo1942/CK42 is the projection used: WGS-84 shows systematic difference of 60m and 300m with respect to other coordinate systems. Problem of secrecy with respect to mapping at 1:50,000 to 1:10,000 scales *(CJH note: the basic contours and hydrographic info are urgently required in any any GIS/MIS covering land degradation and these layers should not be secret – secret / military information includes such features as width and bearing capacity of bridges, depth and bearing capacity of swamp / bog materials, and density and size of forest trees, and all of these should be separate layers on digitised maps and can be excluded from any civilian GIS application).* Note also with ESRI shape (.shp) files one needs to avoid use of Russian letters in names of tables and records, as Russian characters are not supported by the standard Windows-based software.

p31. **Land Degradation Indicators**: major focus on **Soil Erosion**, for which use of Universal Soil Loss Equation (USLE) is proposed. Factors given as 'relief' (i.e. slope & slope mapping), 'precipitation' (i.e. erosivity / intensity of rainfall), 'growth' (i.e. vegetative cover/LAI), and 'soil structure' (i.e. soil erodibility/surface infiltration rates).
3 levels of data access discussed, for 3 different groups of users;

p34. Section 4.1.2. **Indicators and Parameters of System**: 'An environmental indicator is a parameter or set of parameters that summarise in themselves a large volume of data presented as information, which can be used by decision makers or the common public'.

Indicators: Land Resources and Soil Degradation: proposed indicators given as:
- 'Land Use Structure' (presumably via current land use map);
- 'Agricultural lands under water / wind erosion' (but no indication on how this is assessed and what standards are applied);
- 'Land degradation due to construction, mineral resources production, landslides, etc'
- 'Total area of forests';
- 'Area of plantation'.

Indicators: Water resources: (note: these indicators seem to be orientated towards eutrification problems of water bodies and domestic (and not irrigation) water quality parameters. To be useful for irrigation (and also follow both FAO and USBR irrigation water quality criteria) water quality parameters should also include: EC, TDS, TSS, Ca and Mg.

Land Degradation Indicators: 'reduction / increase of productive land as a function of erosion, contamination, urban activity, salinisation etc'. Under a Pilot System the proposed parameter for this would be '% of total area on a regional (oblast) scale'; as a long-term parameter the following would be taken: 'Vegetation Coverage (LAI, leaf area index, & NDVI).

p54 gives structure of database tables in MS Access.

p57 (dates of PC GIS systems incorrect: ESRI PC Arc/Info and Tydac (SPANS) were both in common use by 1988).

Fundamental problem for Kazakhstan given: 'In Kazakhstan it is necessary to solve the problem of accessibility of digital layers. In the current situation there are no State Rules on spatial data exchange and sharing out (of information). Every institution considers digital layers which it is using as private property and it seems to be impossible to have free distribution of digital spatial data for EIMS purposes.'

Arcadis Euroconsult, 2005. Environmentally-friendly Development in Kyzylorda Oblast. The EU TACIS Programme for Kazakhstan:

Technical Note 1, Volume I. May, 2005. Agricultural Production System. Agronomic, financial, economic analysis and policy recommendations.
Excellent data on crop enterprise economics for 1ha units; costs of machinery are a high % of total costs;

Technical Note 1, Volume II. June, 2005. Agricultural Production System. Economic whole farm model analyses. Micro- and Macro-economic considerations on alternative crops.
Analysis undertaken for small farms and large farms: increase in wheat and alfalfa coverage and decrease in rice coverage would reduce greatly water use;

Technical Note 2, Volume I. May, 2005. Outreach to the Rural Areas.

Technical Note 2, Volume II. May, 2005. SME promotion framework in Kyzlorda Oblast.

Technical Note 3. September, 2005. Environmental impact study on irrigation water use in Kyzylorda oblast.
Secondary wetlands of relatively low conservation interest and relatively low economic importance; water saved could be better used for filling NAS area, or for more efficient irrigation water management elsewhere. Remoteness of area further limits economic possibilities. Delta lakes are of higher biodiversity interest, as are the Bozkol and potentially the Telikol area.

Technical Note 4. Water resources accounting and crop production database. (7pp) (GIS/MIS notes)
Database info and shape files listed, and sources given; database structure diagram for relational databases; Technical Note 5. June, 2005. Remote sensing (Space research institute) (21pp)
P5 Satellite map, 25 land cover classes (note MAR<200mm; no rainfed agriculture;
Technique of calculating net irrigation areas from RS; good maps of settlement areas, rice plots

Technical Note 6. June, 2005. Livestock production systems. (47pp)

Technical Note 7. October, 2005. Remote sensing of irrigation and ecological water management practices in Kyzylorda. (A satellite surveillance of evaporative depletion and biomass productivity)
Actual consumptive water use of paddy not more than 600mm; stomatal closure-yield limited to 3.7t/ha; average and crop water productivity of 0.74kg/cu m. Upstream rayon shows 4.0t/ha & 0.79kg/m3; most downstream shows 2.7t/ha & 0.73kg/m3. Total irrigation efficiency 30% but consumptive use in paddy fields is only 15%.

Ecological water depletion (water, wetlands, pastures) is 8 times higher than water depletion from irrigated crops.

Accumulated evaporative depletion is 9.3cu km for Kazakh part of Syr Darya Basin; rainfall is 3.0km3, Syr Darya diversions 6.3km3 (Arcadis 6.4km3).((?? Possibly some confusion re area of Blast w.area of Kazakh basin))

Aral Sea: key statistics are:
1960: 53m amsl, inflow 50km3, salinity 0.5-0.8g/l
2000: 38m amsl, salinity 1.8-2.0g/l
2005: 40m amsl, spillway for dam at 42m to raise N portion of sea.

Syr Darya River:
Basin 444,000km2, 20 million people.
Interstate agreement between 4 countries signed in 1991, ICWC (Interstate Commission on Water Coordination)

Cropping in Kyzyl Orda: rice dominant; some wheat, alfalfa, grass for hay; almost no cotton.

MODIS satellite with high-frequency low resolution (1km and 250m) cover.
LANDSAT ETM7 imagery has 30m resolution (good illustrations covering all downstream parts of basin from Chardara res.)
Paddy water consumption 3400mm; winter wheat 700 and alfalfa 1110mm.
(p25 excellent processed imagery for land use interpretation-paddy red, cotton purple;
p29, fig 13, total biomass production)
(p58, Table 22- water flows between Chardara reservoir and Aral sea; good comparative table:
irrigation diversions are 6,365-6,490km3, Arys river 470km3, return flow 756km3))

Technical Note 8. November, 2005. Improved farming practices and results of on-farm demonstrations. (36pp)
Demonstrations on alternative crops, yields were: cotton 4.7t/ha (labour a major constraint); maize 4.2t/ha, sunflower 3.1t/ha. Major logistics problems in setting up the trials with farm machinery, labour & farmer interest (even with the farmers being paid) major factors.

Technical Note 9. November, 2005. Modelling the Syr Darya River. (29pp)
90year flow record
Natural winter flow around 500m3/s in winter, 1500 in summer; Chardara resv designed to restrict floods to these intensities, with balance sent by flood diversion structure to Arnasai depression.(average 1.400m m3/yr); now hydropower winter requirements mean that yet more water be diverted to Arnasai Depression.
Chardara functions: reliable water supplies for downstream irrigation, especially in dry years;
Flood control capacity during high inflow periods
Kazhydromet provides inflow forecasts, but reservoir management is v.conservative (reservoir is not drawn down at end of irrigation season as it should);
Reservoir operational rule curves based on 90years of records.

Average flows under 4 scenarios (based on reservoir operational rule curves) (Mm3/yr)

	0	1	2	3
	Existing Strctrs	Existing Strctrs	Karaosek Divsn	Koksarai Dam
	Irrigation Flow	Hydropower	Hydropower	Hydropower
Reservoir evaporation	590	564	564	974
Arnasai Spillage	763	908	908	332
Depression Spillage	1367	1524	1479	1086
Abstraction	7997	7834	7836	7684
River Losses	3552	1492	1493	1612
Flow into N Aral Sea	5759	4532	4572	5165

Technical Note 10. November, 2005. Irrigation and Drainage Systems in Kyzylorda Oblast. 59pp.
Tktogul reservoir (Kyrgystan) capacity 19.5cu km; Uzbekistan; Kairakum reservoir (N.Tajikistan) capacity 4.16cu km (Uzbek irrign & Farkhadskaya Hydroelectric Complex); Chardara reservoir (S.Kazakhstan) 5.7cu km
ICWC Interstate Commission for Water Resources Coordination (Tashkent, 1992)
BVO Syr Darya (Syr Darya River basin Authority (created in 1980s)
CWR Kazakh Committee for Water Resources (Ministry of Agriculture, formerly Ministry of Natural Resources & Environmental Protection – now one of 4 committees in Ministry of Agriculture)
(p17 institutions & capabilities – major problems of parallel organisations; under-funding; areas of individual rayvodkhozes cut across irrigation and drainage infrastructure.
(p53 baselines for performance monitoring)

Technical Note 11. December, 2005. Environmentally-friendly development in Kyzylorda Oblast. (Environmental Impact Assessment on Irrigation and River Basin Management).
Average annual inflow into Chardara reservoir: 18.35cu km
Average annual outflow from Chardara reservoir: 16.33cu km
SYNAS-calculations on inflow to Aral Sea, LT average: 1.79cu km
Capacity of Chardara reservoir: 5.13cu km

Capacity of river channel (summer): 1500m3/sec
Capacity of river channel (winter): 700m3/sec

2003 Data:

Inflow Chardara reservoir:	26.28cu km
Resv.Losses & dump to Arnassai Depr.	5.79
Outflow Chardara reservoir	20.49
River flow, Kyzylorda border	15.60
Irrigation use, SKO, for 455,000ha	3.22
Irrigation use, Kyzylorda for 153,000ha	3.27
Ecological use (Pasture use) Kyzylorda	1.08
Inflow Aris River	0.5

Flows between 1992 and 2003:

	M3/sec monthly		Cu Km per year	
Chardara average yearly	531		16.8	
Chardara max	1220	May93	21.4	1993
Chardara min	87	Sep01	12.2	2001
Kyzylorda average yearly	320		9.2	
Kyzylorda max	520	May02	12.9	2002
Kyzylorda min	48	Oct95	8.0	1997

Long tern yearly spills into Arnasi currently 2.3cu km: can be reduced to 0.3cukm.
Improvements in the Chardara Reservoir alone will minimise evaporation & spillage and increase flows to Aral Sea by 4.5cu km

Water quality: 300-1800mg/l, depending on flow volume
Pesticide residues may pose a hazard.
Demonstration plot: water quality: irrigation water: 1400-1700mg/l, with Ca, Mg and SO4 dominant ions, adjSAR<1. Rice plot water: 1500-2050mg/l; Drainage water: 1800-3100mg/l.
Salt content of soils was currently: 0.344% minimum; 0.724% average; 1.010% maximum. Average salinity after rice crop: 0.552%; average salinity after alternative crop 0.880%, with Na, Ca, Cl and SO4 in equal parts. High salinity develops when land is no longer irrigated.
Application efficiency of 45% and conveyance efficiency of 60% gives overall efficiency of only 27% - i.e. 900mm net requirement means 3300mm total gross requirement. Actual efficiency appears even less, some 15-17%.
Average agric water use in oblast: 2080mm

Reduction of irrigation area in Kyzylorda from 272,000 to 150,000ha, of which rice currently occupies 69,000ha. Paddy yields have declined from 5t/ha to 4t/ha. Water used declined from 5cu km to 3cu km.

Paddy Water Use Efficiency at 0.75kg/cu m c.f. world average of 1.1kg
Crop rotation should be changed for small farmers to: 50% rice, 24%maize, 10% wheat, 16% alfalfa, leading to 34% saving in water use, 20% in machinery and 10% in cash needs; but fuel demand will increase by 40% and fertiliser by 7%. Increase in farm income by 20-100%.
Large farms currently have crop rotation of 80% rice, 9% alfalfa and 8:% wheat: new rotation have 48%, 16% and 36% respectively, leading to reduction of water use by 32%, machinery by 15% and cash by 20%. Fuel demand will increase by 4%, and farm income by 34%.

River water shows high Ca and SO4 concentrations, particularly at low-flow periods.
Shrinkage in agriculture due to change from irrigation to hydropower regimes: Toktogul hydropower operation in Kyrgyzstan is main problem area in this respect.
Bad deficiencies in irrigation & drainage infrastructure.
Soil fertility levels are generally satisfactory.

Koksarai reservoir- regulating reservoir, >3cu km volume
Secondary wetlands: little ecological benefit, much wasteful water use-essentially buffer for winter flood waters.
Possible increased salinity with alternative crops – 30% rice in rotation is recommended to reduce salinity.
Additional leaching water recommended before sowing in springtime to further reduce salinity.

Guidelines and reports from LADA

Ponce-Hernandez, R. and Koohafkan, P.: Methodological Framework for Land Degradation Assessment in Drylands LADA. Rome, FAO, 2004. PDF 56 pages.
The document is a power point presentation showing the LADA approach in brief schemes, graphs and flowcharts.

McGarry, D.: A Methodology of a Visual Soil Field Assessment Tool to support, enhance and contribute to the LADA program. Rome, FAO, without year. PDF 50 pages.
The document presents the basic methodology of field assessment promoted in the frame of LADA. The methodology is intended to be applied by the farmers themselves and is simple, fast and cheap.

Lantieri, D.: Potential use of satellite remote sensing for land degradation assessment in drylands. Application in the LADA project. FAO Environment and Natural Resources Service, Sustainable Development Department. Rome, FAO, 2005. Draft document, PDF.
The aim of this report is to review extensively the potential of spatial remote sensing for LADA. It is also an attempt to present a first state of the art of the use of remote sensing for desertification assessment in its broadest sense, and to provide detailed information on remote sensing data and capacities relevant to drylands ecosystems. A particular effort was made to present the information in a way that it can be easily understood by people not particular familiar with remote sensing, in order to facilitate the interaction between the various disciplines within LADA.

Bunning, S. and Lane, A.: Proposed framework for indicators of biodiversity, land and socio-economic condition. Rome, FAO, 2003.
Extract of a paper on selection and use of indicators and methods for assessing biodiversity and land condition conducted as part of a stocktaking of biodiversity issues in the context of the Land Degradation Assessment of Drylands (LADA).

Bunning, S. and Lane, A.: Stocktaking of Dryland Biodiversity Issues in the Context of the Land Degradation Assessment of Drylands (LADA): Selection and Use of Indicators and Methods for Assessing Biodiversity and Land Condition. Rome, FAO, 2003.
The aim of this draft document is to guide and provide options to LADA country teams, in a first instance the pilot LADA project teams in Senegal, Argentina and China, in integrating biodiversity issues into the LADA assessment methodology for application at local, agro-ecological zone and national levels.

International Conventions, Agreements, Guidelines and Norms

1) Конвенция ООН по борьбе с опустыниванием
United Nations Convention to Combat Desertification

2) Соглашение Всемирной Организации по Торговле о Сельском Хозяйстве
WTO Agreement on Agriculture

3) Нормы Европейского Союза по ведению органическому (экологически чистому) сельскому хозяйству
EU Norms for Organic Agriculture

4) Норма ИСО 14000 по Аудиту Окружающей Среды
ISO 14000 Environmental Audit

Carbon Sequestration and Stocks

Several of the papers below resulted from the studies initiated by the Royal Society of London entitled: *'The role of land carbon sinks in mitigating climate change',* with further discussion available on the website: www.royalsoc.ac.uk.

Smith, P. 2004. Soils as carbon sinks: the global context. Soil Use and Management, Vol. 20, pp 212-218.
Soils contain 1500Pg organic-C: 3 times the amount of C in vegetation and twice the amount in the atmosphere. Soil C pools have declined by 40-90Pg C due to human interference (cultivation & disturbance). Annual fluxes land-atmosphere are c. 60Pg C/yr;

Annual emissions to atmosphere:
Fossil fuel & cement production: 6,3 +/- 1,3PgC/yr;
land use changes (cultivation, deforestation): 1.6Pg/yr.

Increase in atmospheric-C: 3,2PgC/yr
Increase in oceanic-C: 2,3 +/- 0,8PgC/yr
Increase in terrestrial-C: 2,3 +/- 1,3PgC/yr
Estimates for potential additional C sequestration:
soil-C: 0,9+/-0,3PgC/yr;
forest trees: 1 – 2PgC/yr.

Soil-C sequestration measures:

	Cropland	Grazing Land	Woodland
Zero / reduced tillage:	X	(X)	(X)
Set-aside / Conservation reserve program	X	X	X
Convert to permanent crops/vegetation	X	((X))	((X))
Convert to deeper-rooting crops/vegetation species	X	X	X
Improve efficiency of animal manure use	X	(X)	(X)
Improve efficiency of crop residue use	X	(X)	(X)
Agricultural use of sewage sludge	X		XX
Application of compost to land	X		X
Mulching	X		X
Rotational changes	X		(X)
Fertiliser use	X	X	(X)
Irrigation	X	X	(X)
Bio-energy crops	X		X
Extensification / de-intensification of farming	X	X	
Organic farming	X		
Convert cropland to grassland or woodland	X	X	X
Management to reduce wind and water erosion	X	X	X

Kyoto Protocol: Articles 3.3 (afforestation, reforestation or deforestation) and 3.4 (C-sequestration in croplands, grazing lands, managed forests, and land subject to re-vegetation): biospheric sinks and sources of C: need for comparison in the commitment period (1st period: 2008-2012) with baseline (1990) emissions. (Marrakech Accords, COP7, 2001: accounting on a net emissions basis).

Duration of soil-C sequestration & permanence of soil-C sinks are major issues:
- soils make take 100years to reach new equilibrium in temperate areas;
- rate of increase falls off over time;
- beneficial effects may be reversed very quickly if soil is re-cultivated.

Soussana, J.-F., Loiseau, P., Vuichard, N., Ceschia, J., Balesdent, J., Chevallier, T. and Arrouays, D. 2004. Carbon cycling and sequestration opportunities in temperate grasslands. Soil Use and Management, Vol. 20, pp 219-230.
Gross primary productivity of intensively grazed grassland (France: 2cows/ha) is 19tC/ha; shoot respiration losses are 7t; root turnover is 9t, grazing removals 3t; soil net biome productivity +0,5t. (Animal excreta additions 0,7; below ground respiration 9,2).
Net annual ecosystem production (NEP) varies between 1-6tC/ha, with water and nutrients being the most important limiting factors.

Over a 20-year study period, C stock changes due to changes in land use practises were quantified:
Intensification of grassland on organic soils: -0,9 to -1,1 tC/ha
Permanent grassland to medium duration leys: -0,2
Intensification of permanent grassland: +0,2
Reduction of N fertiliser input: +0,3
Short duration leys to permanent grassland: +0,3 to +0,4
Increasing duration of leys: +0,2 to +0,5
Conversion to grass-legume mixtures: +0,3 to +0,5

Falloon, D., Powlson, D. and Smith, P. 2004. Managing field margins for biodiversity and carbon sequestration: a Great Britain case study. Soil Use and Management, Vol. 20, pp 240-247.

Carbon sequestration potential of arable land management strategies for European soils:

Land management practice	Potential C sequestration rate (tC/ha/yr)	Additional C savings (tC/ha/yr)
Animal manure incorporation (6,1-20t/ha/yr)	0,37	
Sewage sludge application (1t/ha/yr)	0,26	
Cereal straw incorporation (2-10t/ha/yr)	0,69	
Conversion to no-till farming	0,39	0,02[1]
Agricultural extensification (ley-arable rotation)	0,54	
Natural woodland regeneration on arable land	0,62	2,8[2]
Bio-energy crop production on arable land	0,62	6,0[3]

[1]Fossil fuel saving;
[2]vegetation C accumulation; [3]vegetation C accumulation: of this, 2,1t/ha/yr represents energy substitution potential.

Cerri, C. C., Beroux, M., Cerri, C.E.P., and Feller, C. 2004. Carbon cycling and sequestration opportunities in South America: the case of Brazil. Vol. 20, pp 248-254.
Map of soil-C stocks (0-30cm) show roughly equal proportions of land within the classes 1,5-3, 3-4, 4-5 5-7 and 7-45tC/ha.
No-tillage: c.18m ha of land are under no-tillage. Average benefit is 0,5tC/ha/yr for 0-10cm depth. Benefits in temperate areas with winter wheat under 20 years of no tillage showed C-fixation of 6,7tC/ha for 0-20cm layer (i.e. average of 0,34tC/ha/yr). Further benefit is 60-70% lower fuel consumption.
Sugar cane: benefits in cane-alcohol production, alcohol used for vehicles and substituting for fossil fuels (average production: 6000litres alcohol/ha/year; cost of production US$0,22/litre).
Further benefits in green-cane harvesting (no burning): some 20% of the land (1,5M ha): 0,32tC/ha/year accumulated over a 12-year period for 0-20cm depth (2 cane cycles).
Burning also produces6,5kgCH4/ha, CH4 having a global warming potential of 21
Use of bagasse (residues) for fuel for power station (2,35 dry residue = 1tonne coal): average bagasse yield (@ 60t cane/ha) is around 15t/ha @ 25% dry weight.

Smith, K. A. and Cohen, F. 2004. Impacts of land management on fluxes of trace greenhouse gases. Soil Use and Management, Vol. 20, pp 255-263.
Global warming potentials (c.f. CO2) over 100-year horizon are 23 for CH4 and 296 for N20. Concentrations of CH4 have doubled. Rice cultivation , particularly development of highly-reducing conditions, have accelerated CH4 production. Nitrous oxide is produced if organic soils are drained, although production of CH4 decreases.

Smith, P. 2004. Monitoring and verification of soil carbon changes under Article 3.4 of the Kyoto Protocol. Soil Use and Management, Vol. 20, pp 264-270.

Mikhailova, E. A., and Post, C.J. 2006. Organic-C stocks in the Russian Chernozem. European Journal of Soil Science, Vol. 57, pp 330-336.
The study covered quantities of C held at depths 0-100cm, 100-200cm, 200-300cm in chernozem soils under different long-term land uses. Organic C in top 2m under native grassland was 462t/ha; under yearly-cut meadow 451t/ha; arable 387t/ha; continuous fallow 349t/ha, implying a release of some 75t/ha from long-term cultivation. Quantities of carbon held at depth were considerable: under native grassland, 18-26% was held between 1 and 2m. Average percentages of the total profile-C held at the 3 depth ranges were:

	0-100cm	100-200cm	200-300cm
Native grassland:	69%	23%	8%
Continuous fallow:	73%	20%	7%

Woodwell, G. M. 1970. The energy cycle of the biosphere, in *The Biosphere* - a Scientific American Book, pp26-36.
Definition of Gross production (including plant respiration), Net production, and net ecosystem production (part stored as growth). Classic measurements at Brookhaven National Laboratory, New York, oak-pine forest:

Vegetation/ Ecosystem/Parameter	kgOM/m2	kgC/m2	tC/m2
Oak-pine forest,Brookhaven:			
Gross Production (total fixed)	*2,65*	*1,08*	*10,8*
Net Production	1,20	0,49	4,9
Net Ecosystem Production (net storage)	*0,55*	*0,22*	*2,2*
(wood 0,50, roots/humus 0,05kgOM/m2)			
Net Production:			
Sugarcane (Hawaii)	9,4	3,83	38,3
Corn (total: US)	4,0	1,63	16,3
Coral reef algae	4,9	1,99	19,9
Tropical forest (West Indies)	6,0	2,44	24,4
Oil palm plantation (Congo)	3,7	1,51	15,1
Grassland (New Zealand)	3,2	1,30	13,0
Scotch pine (England)	1,6	0,65	6,5

Ratio of C: dryOM: average: 40,7%; range 36,7% - 45,8%.
For temperate forests, 55% of energy is used immediately for respiration.
Increase of 10% in atmospheric CO2 concentration has led to 5-10% increase in net production figures (vegetations, crops) over the previous 120years.

Bolin, B. 1970. The carbon cycle, in *The Biosphere* - a Scientific American Book, pp49-5forest,6.
Daily variation in CO2: mean (1970) 320ppm; noon, above forest, 305-310; dawn 400ppm.
Maximum net fixation (rain forests): 1-2kgC/ha/yr.

Soils and Land Resources

FAO World Reference Base for Soil Resources, 1998. The Soil Map of Kazakhstan.

No.	Colour	Description	Location	Elevation(m)	MnAnRainfall
105	Dk green striped	Cambisol, leptic, skeletic	High areas, SE	>1500	600-900
111	Dk red striped	Kastanozem	Higher areas, SE	1000-1500	600-800
215	Dk pink	Kastanozem, calcic, humic	Jagabli	1000-1500	600-800
102	Orange striped	Calcisol, haplic	Baidebek	200-500	300-400
204	Lt orange	Calcisol, haplic	Chimkent	300-1000	350-700
202	V lt yellow	Calcisol, aridic	Arys	180-250	200-350
408	Vlt yellow, fine black stipple	Calcisol haplic	Low floodplain, Syr Darya	180-210	200
329	Orange	Solonchak, calcic, yermic, sulfatic	Sozak	250-550	200-250
103	Yellow striped	Calcic, leptic	Edge of Karatau	600-1000	250-400
305	Yellow	Cacisol, sodic, takyric (magnesic)	W bank Syr Darya	180-210	150-200
425	Purple pink	Solonetz, magnesic, calcic	Plain S of Turkestan	180-200	200-300
414	Lt green	Fluvisol, gleyic, humic	Syr Darya floodplain	170-200	150-250
403	Lt yellow, slight stippling	Arenosols, aridic	SE deserts	200-350	100-200

Key to numbering:
100: IFNT94023 Mountain Soils
200: Soils of the foothills, piedmont plains and kettle valleys
300: Zonal soils of the plains
400: Intrazonal soils
500: Complexes of soils

Annex B: Analysis of Soil and Bonitet Assessment Mapping and Reporting at Selskiy Okrug level: 1:10.000 Mapping for Karamurt SO, Sairam Rayon

Reports and accompanying 1:10.000-scale mapping available are the following:

- *Agropedological report on the Kokhoz named after Kirova, Sairam Rayon, Shymkent Oblast, 1963.*
- *Explanatory note to the bonitet assessment and agriculatural soil map of Karamurt Selskiy Okrug, Sairam Rayon, South Kazakhstan Oblast, Kazakhstan. Shymkent, 2006.*

It is understood that an additional bonitet reassessment study and report was undertaken around 1978-79 for this Kokhoz / (Selskiy Okrug).

The initial (1963) report showed full soil descriptions of the major soil types (p15 and onwards) and analysis of both chemical (including fertility) and physical characteristics. The format, illustrated with some results from two typical profiles, is the following:

	Humus%	**Total P%**	**HCO3 %**	**Total N %**	**Exch. Cations (me/100g)**			**Pavail**	**Kavail**
					Ca	**Mg**	**Na**	(mg/kg)	(mg/kg)
Profile, P-59									
0 -10	2,62	0,174	3,42	0,210				2,05	34,0
10-20	2,54	0,107	3,53	0,193				1,98	37,2
22-32	1,71		6,15	0,154					
38-48			9,29						
70-80			14,53						
135-145			11,87						
Profile, P-39									
	2,16	0,143	3,99	0,160	13,2	2,0		1,61	34,8
	2,32	0,124	4,16	0,168	10,4	2,4		1,14	32.8
	1,86	0,138	3,70	0,159	5,8	4,8		0,62	
	1,72		4,16	0,158	10,0	3,2			
			4,90		9,6	3,2			
			4,56						
			3,53						
			5,30						

The format of the mechanical analysis, given here for profile P-59, is the following:

Depth(cm)	Coarse Sand	Fine Sand	Coarse Silt	Med.Silt	Fine Silt	Clay
Size(mm):	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001
0 -10	0,26	9,69	42,61	17,09	14,44	15,91
135-145					19,51	19,47

The 2006 bonitet reassessment mapping and reporting showed a high density of sample points (approx. 20/sq km) with humus content (for subsequent lab analysis)and soil texture (field analysis: 5% of samples for subsequent land analysis) being undertaken at all points. Bonitet reassessment entailed measurement of humus (0-50cm sampling), mechanical analysis, and correlation with a sampling of yield of a wide range of crops. Calculation sheets were presented in the report for bonitet assessments: one particular soil mapping unit, with a mean bonitet of 28,4, showed a range within the unit of 16,0-35,8.

Also given in the 2006 report were details on yields of the major crops grown over the four previous available years (in this case 2001-2004), agricultural land use breakdown in the SO (ha of the major crops), and details on a wide range of agro-meteorological parameters (monthly mean figures).

Karamurt SO: Crop yields (in Centners / Hectare) over four consecutive years (2001 – 2004)

№	Crop	2001	2002	2003	2004	Average
1.	Winter wheat	12,9	19,3	15,2	22,3	17,4
2.	Spring barley	5,1	11,4	-	11,7	9,4
3.	Safflower	5,7	6,9	11,3	5,4	7,3
4.	Garden	21,8	23,1	17,1	25,9	21,9
5.	Corn (grain)	20,7	18,1	18,2	20,4	19,3
6.	Potato	114,7	116,7	122,7	131,0	121,3
7.	Onions	277,5	219,2	243,2	240,4	245,0
8.	Vegetables including:					
	Cabbage	206,7	219,8	201,6	211,7	210,0
	Cucumbers	200,4	124,5	216,1	164,2	176,3
	Tomato	217,7	133,7	233,5	195,0	194,9
	Beet	58,0	-	227,3	234,0	230,6
9.	Long-term grasses	21,4	30,2	33,1	32,9	29,4
10.	Melons	214,1	213,2	217,5	218,4	215,8

Agricultural Land Use in Karamurt Selskiy Okrug (2005)

№	Crop	Area (ha)	Area (%)
1	Winter wheat	1950,7	39,2
2	Spring wheat	230,0	4,6
3	Barley	5,0	0,1
4	Saplings	413,6	8,3
5	Perennial grass	1448,6	29,1
6	Garden	392,0	7,9
7	Water-melons	5,0	0,1
8	Vegetables	137,6	2,8
9	Safflower	186,0	3,7
10	Corn (grain)	75,5	1,5
11	Sunflowers	55,9	1,1
12	Legumes	34,6	0,7
13	Onions	12,5	0,3
14	Corn (forage)	25,0	0,5
	Sum total	**4972**	100,0

Karamurt Meteorological Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Mo Temp	-2,3	-0,7	5,7	13,2	19	24,1	27	25,4	19,6	11,9	5	0,4	12,3
Abs Max Air Temp	20	24,4	24,9	27,7	32	35,9	36,8	35,7	32,8	29,1	21,3	16,8	36,8
Abs Min Air Temp	-20,5	-15,8	-5,8	3,6	4,8	12,3	13	8,7	-0,6	-3,1	-9,5	-15,7	-20
Avg Mo Precipitation (mm)	60	63	69	78	42	17	7	3	7	35	52	64	517
Avg Mo RH	72	72	70	61	52	42	33	33	35	50	66	72	55
Avg Mo Windspeed(m/sec)	2,1	2,5	2,8	3,2	3,3	3,5	3,4	4,0	2,8	2,5	2,2	2,0	2,9
Sum Temp >10deg													4100
Date of last frost				9th									
Date of first frost										19th			
Avg frost-free period(days)													189
Average Growing Period(days)													237
Depth of snow cover(cm)													15-20
Depth of soil freezing(cm)													10-15
Average Evapotranspiration(mm)													1250

Source: GosNPCZem: ' Explanatory Note to the Agricultural Soil / Bonitet Assessment Map of Karamurt Selskiy Okrug, Sairam Rayon, SKO, Kazakhstan. (Shymkent, 2006)'.

File: KAZ\V4\KaramurtMet.xls

The soft-copy version of the 2006 mapping was kingly made available to the Consultants by GosNPCZem in both ArcGIS (vector) and scanned JPEG formats. ArcGIS attribute data included full information on the polygons (with different polygon shading reflecting the bonitet ratings) but minimal basemap information (the latter, however, was given on the scanned JPEG file.) Also although sample point positions were covered as a separate layer (point data), the analytical data was not yet in soft copy format. The consultants have obtained photocopies of all this data, and are in the process of entering this into Excel format.

Consultants' Assessment of the Mapping and Reporting and its Applicability for EMIMS:
Soil Analysis and Properties:
Soils are silt loam (heavy) to silty clay loam in texture and have a high carbonate content (P-59 having a very high carbonate content), these characteristics being typical of loess-derived soils. Organic carbon of the profiles of the 1963 study were at least moderate (>2%), but inspection of the 2006 data showed that average organic-C levels were considerably lower than those for 1963. Follow-up work on this is urgent, and this is a key land degradation indicator. With large amounts of free carbonate in the soil – and even in the surface horizons – available-P levels are low. Fertiliser P will thus have to be applied, as well as the usual N. Exchangeable Mg and Ca levels are high (as expected). If the soils were to be irrigated and thus high yields and high fertiliser applications would be required, further soil analysis should be undertaken to include Mg, K and S analyses.

With very high silt contents, available water holdling capacities (AWC) would be expected to be very high: at least some 22% (vol/vol%) for the topsoil, and 18% for subsoil materials. However, with high silt contents and low sand contents, bearing capacity of the soils when wet would be very poor: winter and early spring cultivation activities would be adversely affected.

Although not given in these analyses, data from elsewhere in the Rayon shows that soil pH values are around 7,5 for topsoils and 7,9 for subsoils for well-drained sites, and slightly higher for irrigated lands in alluvial or colluvial sites. Together with the high carbonate levels, this means that many trace elements (notably Fe, Cu, Zn) could become unavailable, particularly for perennial crops (and notably for fruit crops such as apples). Foliar sprays could be required for such higher-value perennial crops, and application to the land of the maximum amounts of organic manure and compost should be applied to all crops. Consideration should be given to application of N-fertiliser as sulphate of ammonia as that both contains sulphur and has a long-term acidifying affect on the soil. (A reduction of the topsoil pH from 7,5 to 6,5 would improve availability of trace elements and phosphate.)

Meteorological and Land Use Data and Crop Yields:
Met data is very similar to that of Shymkent except that average rainfall at 517mm is less than Shymkent's average of 630mm. Factors affecting potential evapotranspiration are also slightly less favourable than those at Shymkent: windspeeds are somewhat higher, as are mean temperatures. ETo is thus slightly greater (1250 cf 1150mm).

Land use in the SO is dominated by winter cereals and permanent pasture. For summer cropping, grown under irrigation, vegetables (notably potatoes) and corn (grown for both grain and fodder) are the dominant crops.

Yield figures are significantly less than those quoted at farms in the central and NW parts of the same Rayon (Sairam). Winter cereals showed average yields of just 17,4cnt/ha as compared to normal yields elsewhere in the Rayon of around 24cnt/ha. Interestingly, very low yields were obtained in 2001 (12,9cnt) which was a poor year as analysed in the soil water balance exercise based on the nearby Shymkent station's daily rainfall data (see **EMIMS Guidelines, Annex E**). The 2002 and 2004 seasons were very much better, and this is born out by the better than average Karamurt yield figures. As observed elsewhere, Spring cereal yields were extremely low in the years when harvesting was undertaken.

Yield figures for summer crops can not be judged in relation to season's rainfall, as all of these crops are grown under irrigation.

Mapping and reporting:
The mapping and data covered by this work represents the best source available for land and water assessments at SO and Rayon level and covers both baseline data (the original 1960s work) and recent updates which are effectively current re-assessments (40+ years later). Indicators and parameters covered by this work include:

- changes in carbon stocks: analyses of soil organic matter content are undertaken at a detailed level and can be compared to results from the earlier survey; copy yield and land use data can be used to generate total carbon in live biomass within the SO;
- changes in fertility parameters (available nutrients)
- changes in bonitet assessments between the two years;
- changes in overall crop yields between the two years.

Some further reassessment and correlation work at this stage would be very useful. This would include comparisons of the land use assessment made for the report (2005) with both the data from the SKO Statistics Agency on crop areas and yields (2005 and 2006), and also with the land use patterns as observed on the Google Earth Imagery (again 2006 and 2005). Correlation work also needs to be undertaken between the analyses undertaken in these two reports with the work available from the nearby Stationary Observation Sites (SES).

Overall Assessment:
The Soil and Bonitet Asssessment mapping at Selskiy Okrug level represents the most valuable single source of information at detailed level concerning land degradation. The work is directly applicable to assessments undertaken at both So and Rayon level, and, by inspection and overlays with the original mapping, to assessments undertaken at individual farm enterprise level.

Annex C: Soil Resources of the Southern Kazakhstan Area

Table of Contents:

Mountain soils

1. Mountain meadow and steppe alpine and sub-alpine soils

1.a. Mountain meadow and steppe alpine immature soils are the most widespread among the soils of the alpine belt, especially in its upper part. They are formed on moderately and steeply sloping land with very rough, stony marl of dense rock weathering, almost devoid of matrix. The vegetation is very poor. Density of sward doesn't exceed 5-15%, and its height is mainly 3-5 to 10, sometimes 15 cm.

The morphological characteristics of these soils are very shallow and stony profiles. Often the surface of the soil is covered with a layer of crushed stone and rock. The thickness of the very weakly developed humus horizons usually doesn't exceed 20-30 cm. Within the humus horizons there are mainly gray and cinnamonic and brown soils. Downward the color becomes darker, and in the areas of limestone it becomes often red and brown. The structure is feebly marked, mainly friable crumbly and silty. The profile is slightly consolidated. At the shallow depth the soil is stretched under wood and crushed stone marl or dense cover. Among these soils there are two main genetic variants – leached (mainly on acid parent materials) and carbonate (on limestone).

Profile 856 (**Table 1**) (Mountain meadow and steppe alpine immature soil) is situated at a distance of 5,3 km to N-E of Sayram peak of Ugamskiy range at the edge of a moderate (15%) S-SW-facing slope at an altitude of 3700 m, and underlying very light short grass vegetation. Density of sward is 3-5%, its height is 3-15 cm. 80-90% of the soil surface is covered with the crushed stone. The thickness of the feebly marked, very stony, gray and brown residual humus horizon (A+B) is 30 cm. There is no HCl effervescence down to the bottom (10 cm).

Mountain meadow and steppe alpine primitive soil is almost devoid of humus and nitrogen, especially the leached variant. In the lower horizons there is an increase of humus content. The absorbed complex is saturated mainly with calcium. The sum of exchangeable cations is not very high (20-22me/100g soil). In some cases, it increases in the lower horizons, and this is explained by the better conditions of weathering at the shallow depth at which this material occurs. According to the mechanical analysis the soils are light loams, and characterised by a high content of stony (> 3 mm) and sandy fractions. The areas of the given soils are very low productivity range land and waste land: however, the areas in which they occur are important for biodiversity conservation reasons and are scenically spectacular, and thus have considerable appeal for tourism and wildlife conservation.

1.b. Mountain meadow and steppe alpine normally developed soils are formed mainly in the low part of the alpine belt on the slanting and steep slopes, dominantly of northern and western expositions as well as at the more true surface of high-mountain valleys. The soil parent materials are superficial, stony, of mainly loamy and coarse textured deposits of ancient seas. Density of sward varies between 20-60%. There are acid and carbonate genetic groups of these soils.

Profile 527 (**Table 1**) (Mountain meadow and steppe alpine normally developed soil) is situated at the distance of 12 km to the east of the center of collective farm facilities Pobeda: at the upper path of the southern slope at the altitude of 2820 m. Density of sward is 40-50%, its height is 5-25 cm. HCL effervescence from the surface. The surface of the soil is covered with the crushed stone of the gray limestone.

$A_{д}$ – 0-10 cm. Dark gray with subtle brown shade, fresh, slightly consolidated, with lots of roots, cloddy and silty, medium stony, medium loamy.

AB – 10-30 cm. Gray and brown, slightly damped, slightly consolidated, cloddy and silty with grains, medium stony, medium loamy.

B – 31-45 cm. Brown with gray shade, slightly moist, with few roots, gravelly and stony, medium loamy.

C – 45-90 cm. Compact crushed stone of gray limestone.

The given soils are characterized by quite high humus content (7-9%) and nitrogen (0,4-0,7%), as well as medium relation of organic carbon to nitrogen (8-10), narrowing toward the depths. In absorbent complex the main position belongs to the calcium (90-95%). The sum of absorbed bases in the upper horizon varies in the limits of 20-25mg. per 100 g of soil and is reduced toward the depth.

The mechanical content of the soil is medium loamy. The significant content of stony particles, and sandy particles of the acid soil is marked. The given soils serve as low-productivity summer rangeland.

1.c. Mountain meadow and steppe sub-alpine soils are dominant in sub-alpine belt. They are formed at the steep and slanting slopes, mainly northern expositions. Density of sward is 60-80%, grass height is 25-50 cm. The soil-forming rocks are mainly eluvial stony loam. There are carbonate and acid types of soils.

The main morphologic features of the given soils are significant thickness of humus horizons (A+B), --- 50-80 cm, availability of dark gray cloddy horizon in the upper part of the profile, predominance of brown and gray colors in transitional horizons (AB and B), slight --- in humus horizons, slightly consolidated profile composition; relatively heavy mechanical content of matrix and highly stony humus horizons.

Profile 532 (**Table 1**) is situated at the distance of 6 km to the E-SE of the village Novo-Nikolaevka at the altitude of 2250 m., on the steep northern slope (32%), faced to the river Dzhabagalysu. Density of sward is 60-80%, the height of the grasses is 25-50 cm. Effervescence from HCL from the surface is slight, from 16 cm - violent.

A_1 – 0-16 cm. Dark gray, fresh, slightly consolidated, soddy, cloddy and silty with grains, medium stony, heavy loamy.
A_2 - 16-30 cm. Brown and gray, fresh, slightly consolidated, soddy, cloddy and silty with grains, medium stony, heavy loamy.
B_1 - 30-60 cm. Brown and gray, slightly damped, slightly consolidated, slightly soddy, cloddy and silty with grains, medium stony with grains, heavy loamy.
B_1 - 60-80 cm. Lurid, slightly damped, slightly consolidated, strongly stony, heavy loamy.
C – 80-110 cm. Pale-yellow and brown, slightly damped, slightly consolidated, strongly stony, heavy loamy with inclusions of large pieces of gray limestone.

These soils are characterized with high content of humus (up to 13%), nitrogen and great sum of absorbed cations (**Table 1**), carbonates on the surface of carbonate soils, increasing toward the depth that testifies to the intensive leaching of these soils. The mechanical content of the given soils is mainly heavy loamy with high content of stony and gravelly particles (> 3 mm) and almost complete absence of sandy ones. The soil matrix is represented mainly by the silty and clayey particles. The tracts of mountain meadow and steppe sub-alpine soils are used as high-mountain summer ranch land.

2. Mountain and steppe alpine and sub-alpine soils.

Mountain and steppe alpine and sub-alpine soils are developed in comparatively more xerothermic conditions than the mountain meadow and steppe soils. They occupy relatively better warmed high-mountain slopes and dry valleys receiving comparatively fewer atmospheric moisture due to the blowing of the snow in winter and are relatively fewer provided with the soil moisture due to the low capacity of the soil-forming substrate and vicinity of rock debris bedding.

2.a. Mountain and steppe alpine normally developed soils (Profile 111 – **Table 1**) are situated at the distance of 12 km to the S-E of the central facilities of the collective farm «Tonkurus», in the middle part of the slanting S-E slope at the altitude of 3340 m. Density of sward is 25-35%, the height of the grass is 10-15 cm. The thickness of gray and light brown humus horizon growing lighter downward is (A+B) 47 cm, including A=13 cm (brown, cloddy), AB=12 cm (brown, cloddy), B=22 cm (light brown, structureless). Effervescence from HCL from 12 cm.
The mechanical content of the soils is loamy, dominantly stony. The tracts of the given soils represent summer ranch land with low productivity.

2.b. Mountain and steppe sub-alpine soils are developed at the convex water-dividing surfaces in the conditions of increased dryness of the soil climate. They belong to the shallow profile with strong stony features, with 30-60 cm of roughly grinded rocks.

Profile 860 (**Table 1**). Mountain and steppe sub-alpine acid soil is situated at the distance of 4 km to the N-W of Sairam pick at the absolute altitude of 2500 m. Density of sward is 60%, the height of the grass is 5-20 cm. The thickness of humus horizons is (A+B) 55 cm, including $A^{д}_1$ = 6 cm (dark brown, powder-like, silty), A_2 = 8 cm (brown, powder-like, silty), B_1 = 16 cm (gray and light brown, cloddy and powder-like, silty), B_2 = 25 cm (light brown, powder-like, silty). There is no effervescence from HCL to the bottom. 20-30% of the surface of the soil is covered with boulders. The whole profile is pebble. The mechanical content of the soils is loamy, stony. They can be used as ranch land in winter.

3. Mountain and meadow hydromorphic alpine and sub-alpine soils.
These soils occur in localized depressions and other low parts of the landscape.

3.a. Mountain and meadow hydromorphic alpine, illuvial and humus acid soil. Profile 112 –(**Table 1**) is situated at the distance of 12 km to the S-E of the central facilities of the collective farm «Tonkurus» in the upper part of the river-valley Baldabrek at the altitude of 3370 m. The thickness of humus horizons is (A+B) 85 cm, including soddy ones 12 cm. Darker illuvial horizon is situated at the depth of 35-65 cm. Serves as summer ranch land.

3.b. Mountain and meadow hydromorphic sub-alpine acid soils. Profile 521 (**Table 1**) is situated at the distance of 11 km to the S-E of the village Pervormaiskoye, in the middle part of the steep (20^0) northern slope of the range Karzhantau at the altitude of 2350 m. There is no effervescence from HCL to the bottom.

$A^{д}_{1}$ 0-15 cm – Brown and gray, slightly damped, slightly consolidated, soddy, cloddy and silty with grains, medium stony, slightly loamy.

AB 15-34 cm - as above, but darker and less soddy than the upper one.

B 34-64 cm – Dark gray, with brown color, slightly damped, consolidated, slightly soddy, cloddy and silty, slightly stony, slightly loamy.

BC 64-100 cm – Lurid, damp, slightly consolidated, cloddy and silty, slightly stony.

C_1 100-125 cm. – ochre and red, damp, consolidated, mixed with red clay, strongly stony, marl of weathering of the gray limestone.

Table 1. Chemical & physicochemical properties of mountain meadow-steppe soils, mountain-steppe soils, mountain-meadow hydromorphic soils, & mountain dark-colored alpine & subalpine soils

№ of Profile	Sample depth, Cm	Humus, %	Total nitrogen	C:N	$CaCO_3$	Absorbed cations, мг – экв. Per 100 g.							pH suspensions		Mobile forms			
						Ca··	Mg··	Na·	K·	Al··· according to Sokolov	H· according to Sokolov	Sum	Water	Saline	%	mg per 100g		
															Fe	Hydrolyzable nitrogen	P_2O_5	K_2O
1.a. Mountain meadow-steppe subalpine immature leached soils																		
856	0-10	0,4	0,03	8,6	-	21,4	нет	-	-	-	-	21,4	7,3	6,2	-	-	1,4	3,2
	15-25	0,4	0,03	7,7	-	17,9	-	-	-	-	-	17,9	7,4	6,1	-	-	1,6	3,7
	90-100	1,2	0,08	8,7	-	17,9	-	-	-	-	-	17,9	7,7	6,7	-	-	-	-
1.b. Mountain meadow-steppe alpine normally developed calcareous soils																		
527	0-10	9,1	0,65	8,1	1,4	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-20	7,8	0,56	8,1	1,4	-	-	-	-	-	-	-	-	-	-	-	-	-
	35-45	3,3	0,28	6,7	2,7	-	-	-	-	-	-	-	-	-	-	-	-	-
1.c. Mountain meadow-steppe subalpine calcareous soils																		
532	0-10	12,9	0,59	12,7	2,7	33,9	5,4	-	-	-	-	33,9	7,6	-	-	16,4	3,9	37,8
	20-30	8,5	0,60	8,2	5,9	39,3	Нет	-	-	-	-	39,3	8,0	-	-	13,4	1,6	19,6
	40-50	4,6	0,31	8,6	8,8	26,8	нет	-	-	-	-	26,8	8,2	-	-	11,8	0,8	9,6
2.a. Normal mountain-steppe alpine soils																		
111	0-10	2,8	0,19	8,5	-	18,8	1,9	-	-	-	-	20,7	7,0	6,2	-	7,8	3,7	6,0
	14-24	2,6	0,18	8,4	0,5	18,6	1,9	-	-	-	-	20,5	7,4	6,6	-	7,0	2,9	4,0
	40-47	1,2	0,11	6,3	13,9	-	-	-	-	-	-	-	8,2	7,0	-	3,3	-	-
2.b. Mountain-steppe subalpine acidic soils																		
860	0-6	5,9	0,31	11,0	-	19,0	Нет	-	-	-	-	19,0	5,6	4,9	-	-	-	-
	6-14	3,4	0,20	9,9	-	19,0	Нет	-	-	-	-	19,0	5,7	4,7	-	-	-	-
	15-25	1,9	0,12	9,2	-	19,0	Нет	-	-	-	-	19,0	5,6	4,5	-	-	-	-
	35-45	1,1	0,06	10,6	-	12,6	Нет	-	-	-	-	12,6	5,7	4,5	-	-	-	-
3.a. Mountain-meadow hydromorphic alpine alluvial-humus acid																		
112	0-10	35,0	1,67	12,1	-	70,6	2,0	-	-	-	-	72,6	-	-	-	-	-	-
	20-30	9,3	0,77	11,5	-	33,0	0,4	-	-	-	-	33,4	-	-	-	-	-	-
	45-55	15,0	0,80	10,8	-	17,8	0,9	-	-	-	-	18,7	-	-	-	-	-	-
	68-78	10,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	98-108	1,4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.b. Mountain-meadow hydromorphic sub-alpine acid soils																		
521	0-10	9,5	0,47	11,7	-	32,1	3,6	0,03	0,88	3,7	0,2	40,5	6,3	5,5	0,32	25,8	29,3	45,8
	20-30	3,5	0,20	10,0	-	19,6	Нет	-	-	1,3	0,1	21,0	6,3	5,4	0,73	-	20,3	30,6
	45-55	2,4	0,16	8,7	-	19,6	1,8	-	-	2,3	0,1	23,8	6,0	4,9	0,86	20,9	19,3	24,0

4. Mountain brown soils.

These soils are formed in the conditions of medium- and low-mountain landscape, mainly on the steep and slanting slopes of the northern expositions including North-Eastern and North-Western ones. On the slopes of the northern expositions of the medium-mountain there are mainly dark brown soils, on the slopes of other expositions in the same conditions as well as on the low-mountain slopes there are mainly mountain light brown soils. Among the mountain dark brown soils there are mountain and forest multi-humus soils and medium-humus broad-leaved forests as well as proper mountain dark brown medium-humus soils of grassy and bushy tracts.

4.a. Mountain dark brown normal soils.

Profile 518 (**Table 2**) is situated at a distance of 5 km to the E-S-E of the village Pervormaiskoye, in the middle part of the steep (27^0) northern slope of the range Karzhantau at the altitude of 2100 m with grass and bush vegetation. Density of sward is 50-60%, grass 40-50%, the height of the bushes 2-3 m, grass – 15-50 cm. Effervescence from HCl from 58 cm.

$A^{д}_1$ 0-20 cm - Brown and gray, fresh, mellow, soddy, cloddy and granular, medium stony, slightly loamy.

B_1 20-38 cm – Brown with gray color, fresh, slightly consolidated, medium soddy, nuciform and granular, slightly stony, slightly loamy.

B_2 38-58 cm – Brown with gray color, slightly consolidated, medium soddy, nuciform and granular, slightly stony, slightly loamy.

B_3 58-75 cm – yellow and brown with white spots of limestone crushed stone, slightly consolidated, nuciform and cloddy, strongly stony, slightly loamy.

$C^{к}_1$ 75-115см – Pale-yellow and brown with white spots of limestone crushed stone, slightly consolidated, low nuciform, strongly stony, heavy loamy.

4.b. Mountain light brown soils (carbonate).

Profile 295 (**Table 2**) is situated at a distance of 3 km to the E-S-E of the station Tyulkubas in the upper part of the steep N-N-E slope of the Alatau mountains at the altitude of 1450 m. Effervescence from HCl from the surface. The surface is covered with the crushed stone up to 10%.

A – 0-20 cm. Brown, mellow, soddy, silty and cloddy and granular, slightly stony, medium loamy.

B_1 - 20-60 cm. Light brown with gray color, dry, consolidated, soddy, granular and nuciform, medium stony, heavy loamy.

B_2 – 60-90 cm. White and yellow with gray color, consolidated, nuciform, strongly stony, heavy loamy.

$C^{к}_1$ – 90-110 cm. White and yellow with gray color, dry, loamy.

Table 2. Chemical and physical and chemical properties of mountain dark brown and brown soil.

Profile #	Depth, cm	Humus %	Total N, %	C:N	Ca CO_3	Absorbed cations			pH suspensions		Mobile forms, Mg per 100g		
						$Ca^{..}$	$Mg^{..}$	Sum	Water	Salt	hydrolizd nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
4.a. Mountain dark brown normal													
518	0-10	8,4	0,47	10,4	-	27,4	-	27,4	6,8	6,0	18,2	14,4	58,5
	20-30	3,6	0,29	7,2	-	23,2	-	23,2	7,0	6,2	12,2	9,9	20,6
	40-50	3,3	0,20	9,6	-	21,1	-	21,1	7,5	6,6	11,2	-	11,0
	60-70	2,5	0,17	8,5	3,0	19,0	-	19,0	8,0	-	-	-	-
	105-115	1,2	-	-	31,4	-	-	-	8,3	-	-	-	-
4.b. Mountain light brown carbonate													
295	0-10	4,6	0,30	8,9	1,1	17,8	1,7	19,5	7,3	-	12,7	2,1	47,2
	25-35	2,3	0,18	7,4	6,3	16,7	1,8	18,5	7,8	-	14,0	1,5	18,6
	45-55	1,7	0,14	7,0	15	12,9	1,8	14,7	8,0	-	-	-	-
	70-80	1,5	-	-	30,5	-	-	-	-	-	-	-	-

5. Mountain gray and brown soils are formed on the steep and slanting slopes mainly of southern and western expositions of the medium-mountain landscape, while in the areas of low-mountain landscape they are situated in combination with the mountain light brown soils on the slopes of the northern expositions.
Profile 292 (**Table 3**) (mountain gray and brown normal soil) is situated at the distance of 16,5 km to the north of the village Vannovki on the steep (25^0) S-W slope of Borolday at the altitude of 1000 m. The thickness of humus horizons is (A+B) 90 cm, including:
A_2 = 18 cm (brown and gray, granular and cloddy), B_1 = 18 cm (gray and brown, granular and cloddy and nuciform), B_2 = 54 cm (gray and light brown, granular and nuciform). Effervescence from HCL from 36 cm.

Table 3 Mountain gray and brown soils

Profile #	Depth, cm	Humus %	Total N, %	C:N	Ca CO_3	Absorbed cations			pH suspensions		Mobile forms, Mg per 100g		
						Ca··	Mg··	Sum	Water	Salt	hydrolizd nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5. Mountain gray and brown soils													
1	2	3	4	5	6	7	8	9	10	11	12	13	14
292	0-10	3,6	0,23	9,1	Нет	14,8	1,8	17,6	7,5	6,5	7,3	2,3	45,9
	20-30	1,9	0,15	7,4	Нет	14,8	1,8	17,4	7,6	7,0	6,5	0,5	24,6
	45-55	1,3	0,11	6,8	0,9	14,7	1,8	17,1	7,5	-	4,5	-	25,9
	75-85	1,0	0,10	5,6	1,1	14,8	1,8	16,6	7,6	-	-	-	-

6. Mountain gray earth. The given soils are situated on the steep and slanting slopes mainly in the Northern part of the area, on the slopes of Northern Karatau. They are divided into mountain gray earth: ordinary (northern) and light ones.

6.a. Mountain ordinary gray earth. The profile of these soils is gray, growing brown toward the depth. The thickness of humus horizons varies significantly (in average A+B = 30-60 cm) depending on the thickness of soil-forming rocks and relation of wash-in and out processes, humus content in the upper horizon varies from 1 to 1,8%.

Profile 976 (**Table 4**) is situated on the slanting (12^0) external S-W slope of the Northern Karatau at the altitude of 700 m. The thickness of humus horizons (A+B) is 50 cm, including A_1 = 10 cm (gray schistous), A_2 = 7 cm (gray, light brown, cloddy and granular), B_1 = 20 cm (yellow and brown, nuciform and granular), B_1 = 13 cm. Effervescence from HCL from the surface. Carbonate "mold" in the horizon 30-50. The soil is medium loamy, in humus horizon – medium, deeper – strongly, with 80 cm on the limestone layer. The surface is covered with the crushed stone. In whole, the mountain ordinary gray earth is characterized by low content of humus (1-2%) and total nitrogen (0,06-0,13%) gradually reducing toward the depth. The relation of organic carbon to nitrogen varies significantly (7,5-10,5) and gets narrower toward the depth. Soil-absorbing complex is saturated mainly with calcium, partially with magnesium (that is sometimes absent) and in low quantities with potassium. The content of the exchangeable Natrium is very low. The sum of exchangeable cations varies from 5 to 15 mg per 100 g and sometimes is increased in the horizon «V». The reaction of the soil solutions along the whole profile is alkaline (PH = 8-9) including deeply effervescent gray earth. In spite of the low content of the total nitrogen, the mountain gray earth has relatively many mobile forms, medium quantity of mobile potassium and high quantity of weakly mobile phosphorus. The most part of the soil already contains significant percent of carbonates on the surface (19-60%). The mechanical content of the given soils is mainly stony, medium loamy, silty (mainly large-silty) varieties with low content (10-20%) of muddy particles. The number of the micro-aggregates is up to 50-70% of the soil weight. Quite an extensive tract of mountain ordinary gray earth from the agricultural point of view is assessed as stony bushy mountain ranch land.

6.b. Mountain light gray earth is spread in Southern Kazakhstan area on the N-E slope at the extreme N-W part of Northern Karatau, as well as along the flat mountains of Ulken-Aktau and on the tract Kairaktau. The given soils have low humus content (nearly 1%), insignificant content of total nitrogen (up to 0,13%) and low relation (nearly 7) of organic carbon to the nitrogen. Absorbent complex is saturated with calcium, partially magnesium; the sum of exchangeable bases is not very large (6-8 mg – per 100 g), the reaction of soil solutions is alkaline (pH – 8-9), the carbonate content is very high (> 25%). The soils are practically not saline with freely soluble salts. Its mechanical content is light and medium loamy, silty and sandy and silty, stony with low clay content (~ 10%). The regions of mountain light gray earth are rangeland.

Profile 324 (**Table 4**)(Mountain gray earth light) is situated at the distance of 1 km to the north of the city of Karamola in the limits of slanting slope Kairaktau at the altitude of 350 m. Effervescence from HCL from the surface. Carbonate film on the gruss and crushed stone.

A 0-10 cm. Light gray, dry, lightly consolidated, soddy, schistous, lightly stony, scaled and silty, lightly stony, loamy.
AB 10-20 cm. Brown and gray, dry, lightly consolidated, cloddy, lightly loamy.
B 20-40 cm. Light brown, dry, lightly consolidated, cloddy, lightly loamy.
C 40-47см. yellow and brown, dry, lightly consolidated, silty and cloddy, stony, sabulous. Toward the depth there is a platform of ochre and yellow sandstones.

According to the character of vegetation and morphologic properties this soil is close to the gray and brown sand soils.

Table 4. Chemical and physical properties of mountain gray earth.

Profile #	Depth, cm	Humus %	Total N, %	C:N	Ca CO_3	Absorbed cations			pH suspensions		Mobile forms, Mg per 100g		
						Ca··	Mg··	Sum	Water	Salt	hydrolizd nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
6.a.Mountain gray earth ordinary free-saline													
976	0-10	1,7	0,13	7,6	19,8	14,2	-	14,2	8,2	-	6,1	1,5	29,0
	20-30	1,2	0,10	7,0	25,2	13,1	-	13,1	8,0	-	7,2	0,5	17,0
	40-50	1,0	0,11	5,3	34,3	10,2	-	10,2	7,9	-	4,7	сл	15,0
6.b.Mountain gray earth light free-saline													
324	0-10	0,9	0,08	6,5	14,1	5,0	0,9	5,9	8,4	-	-	-	-
	10-20	0,6	0,05	7,0	16,4	4,1	Нет	4,5	8,7	-	-	-	-
	20-30	-	-	-	18,4	3,3	2,7	6,2	8,8	-	-	-	-

Soils of intermountain plains, sub-mountain and other high and low plains

7. Brown soils

These soils are formed on the surface of high sub-mountain rolling plain separated by valleys of the rivers Sairamsu, Baldabreka, Aksu, Irsu and other smaller rivers. The lower boundary of its extent is at an altitude of 1200-

1250 m, and the upper boundary - 1500-1600 m. Soil parent materials are mostly loessial loams and clays, and seldom eluvial deposits. Ground waters occur at depth and don't influence the soil-formation. The major portion of the area of brown soils is cultivated.

7.a. Brown leached, normal and carbonate. Almost all of them belong to the sub-type of light low humus-containing soil.

Profile 881 (**Table 5**) (brown leached virgin soil) is situated at the distance of 1,5 km to the S-E of the village Vysokoye on the flat surface of slanting submountain plain adjoining to the mountains Aksu-Dzhabagly, at an altitude of 1200 m. Sward density is 100%, the height of the grass is 20-60cm, and that of the bushes 150-250 cm. Effervescence from HCl from 75 cm in the profile:

A_1 – 0-10 cm. Dark brown, gray, dry, lightly consolidated, cloddy, powder like and cloddy, heavy loamy.
A_2 – 10-26 cm. Dark brown, lightly consolidated, cloddy, nuciform and cloddy, heavy loamy.
B_1 – 26-45 cm. Brown, dry, consolidated, lightly cloddy, nuciform, heavy loamy.
B_2 – 45-65 cm. Brown, fresh, lightly consolidated, lightly cloddy, granular, heavy loamy.
BC – 65-75 cm. Light brown, fresh, lightly consolidated, granular, heavy loamy.
C^K_1 – 75-100 cm. Yellow and brown with many white spots and veins of carbonate, fresh, consolidated, small nuciform, heavy loamy.
C^K_2 – 100-160 cm. Yellow and gray, fewer carbonates, lightly moist, lightly consolidated, medium loamy.

Brown soils are characterized by a significantly lower humus content than their mountain analogues. In the upper horizon they contain 4-7% of humus, 0,2-0,35% of nitrogen. The exchange complex is saturated with calcium, in small quantity with magnesium. The sum of absorbed bases is 20-30me/100 g. Brown soils are rich in available potassium, well to moderately supplied with nitrogen and with very variable contents of available phosphorus. The mechanical content of the soil is mainly heavy silt loam. The content of the very fine fraction in the upper horizon is 20-25% and slightly increases in the medium part to 21-29%; thereafter it decreases in the parent rock material to 12-16%. The proportion of the finer size fractions (<0,01mm) is 35-55% of the soil weight. Brown soils are intensively used in rainfed farming, mainly for cereals (wheat and barley). However, most of this cropland needs thorough application of erosion-preventive farming methods, since the characteristics of the landscape (i.e. steep slopes), heavy silt loam soils and great quantity of precipitations favor the development of erosion processes there.

7.b.Brown light leached soils extend to the limits of the zone of mountain brown light soils occupying tracts belonging to the cordon Kara Alma, farms of the crew #3, along the right bank of the stream Tasbulak and at the area of the strip farm "Irsu".

The soils described here are situated on pockets of high plateau land and are derived from loamy and heavy loamy carbonate-rich parent materials. The natural vegetation is dominated by grasses (couch grass, brome, bulbous barley), plus bushes of brier and isolated barberry trees.

Morphologic properties of the brown light leached soils are different from the above-described mountain ones. Mainly these differences are a decrease in humus content in the profile and reduction of its thickness. The upper humus horizon is brown-colored with a yellow tint, its structure is cloddy and granular, formed by earthworm activity. The B-horizon is characterized by a granular structure that is characterised by strong consolidation of the horizon due to its clay accumulation.

Profile # 345 (**Table 6**) presents mechanical analysis of this soil type. This confirms a high content of finer particles (i.e. 53% of material finer than 0,01mm), as well as clay formation and accumulation within the soil parent material. Content of the clay fraction in the upper horizon is 18,8% gradually increasing in the B_2 to 30,6%, and in the parent rock it is again reduced to 20,4%.

The data of mechanical analysis is confirmed by the degree of soil leaching apparent from **Table 7**, with carbonate concretions (measured here as HCO3) occurring deeper in the profile. The level of available phosphorus is low (1,2 mg/100 g of soil), while available mobile potassium is moderate (19,2mg/100g).The sum of absorbed bases is dominated by calcium at 22,0 me/100g soil in the surface horizon, reducing at depth to18me/100g. The content of absorbed sodium in both cases doesn't exceed 0,10me/100g.

The soil is used for rainfed farming, with cereals and lucerne being the dominant crops. In addition, small tracts of these soils are used for irrigated farming of corn.

7.b. Brown leached heavy loamy soil.

Profile 345 (**Tables 6 & 7**) is situated at the distance of 1700 m to the South-East of the farm Koko and 90 m to the south, south-east of Dzhebalgin power station, on the rolling land of Tallas Ala-Tau. The slanting slope of the northern exposition in the medium part of the slope is occupied with a lucerne crop.

A – 0-27 Dark brown with gray tint, dry, heavy loamy, lightly consolidated, cloddy and granular, there are roots of plants and warm travels, no effervescence from HCl, transition is gradual.
B_1 – 27-49 Brown and gray, dry, heavy loamy, very consolidated, some worm channels, no effervescence from HCl, transition is gradual.
B_2 – 49-83 Light gray with brown and pale-yellow tint, fresh, heavy loamy, flimsy cloddy, consolidated less than the previous one. Gradual transition.
C – 83-140 Whitish due to carbonate, fresh, heavy loamy, lightly consolidated. effervescence from HCl from 89 cm.

Table 5. Chemical and physical and chemical properties of brown and gray and brown soils.

Profile #	Depth, cm	Humus %	Total N, %	C:N	Ca CO_3	Absorbed cations			pH suspensions		Mobile forms, Mg per 100g		
						Ca··	Mg··	Sum	Water	Salt	hydrolizd nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
7.a Brown leached													
881	0-10	6,0	0,32	10,9	-	22,9	3,5	26,4	6,9	6,2	7,8	12,7	51,9
	10-20	3,7	0,21	10,2	-	19,2	3,5	22,7	7,3	6,5	5,9	7,5	27,7
	30-40	2,2	0,13	9,8	-	12,3	3,5	15,8	7,4	6,4	2,9	Сл.	20,6
	50-60	1,6	0,09	10,3	-	19,2	Нет	19,2	7,8	7,1	2,2	Сл.	10,4
	65-75	1,5	-	-	-	-	-	-	8,0	7,3	-	-	-
	85-95	-	-	-	32,2	-	-	-	8,5	-	-	-	-
8 Gray and brown leached													
517	0-10	3,2	0,19	9,8	-	18,4	1,8	20,2	7,3	6,6	7,8	4,7	48,7
	20-30	1,7	0,15	6,6	-	14,7	Нет	14,7	7,4	6,7	5,6	1,0	46,6
	45-55	1,3	0,10	7,5	-	14,7	0,9	15,6	7,3	6,2	-	0,4	46,6
	70-80	1,0	-	-	16,1	-	-	-	8,2	7,5	-	-	-

Table 6. Mechanical analysis of brown arable land

Profile #	Sampling depth (cm)	Fraction size, mm								
		3	Sand			Silt			Clay	Total Fine
			3 #1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
345	0-10			0,30	7,78	39,12	13,78	20,08	18,84	52,80
	10-20			0,08	7,45	32,88	12,92	23,73	22,94	59,59
	35-45			0,00	3,66	38,83	13,00	18,34	26,17	57,51
	55-65			0,09	0,79	39,67	11,93	16,92	30,64	59,49
	75-85			0,39	5,18	41,00	11,18	15,97	26,28	53,43
	130-140			0,06	5,07	41,76	16,23	16,52	20,36	53,11

Table 7. Chemical content of brown arable land

Profile #	Depth (cm)	Humus %	Total N %	Total P%	Total HCO3%	Absorbed cations (me/100g)			Mobile(mg/100g)	
						Ca	Mg	Na	P	K
345	0-10	4,07	0,254	0,145	no	22,0	1,0	0,10	1,20	19,2
	10-20	4,20	0,269	0,145	-	21,0	2,0	0,10	0,83	16,0
	35-45	1,94	0,133	0,130	-	18,0	2,5	0,10	0,44	
	55-65	1,37			no					
	75-85	1,16			light					
	130-140	3,15			9,86					

8. Gray and brown soils.

These soils are extended along the high wavy sub-mountain plains of Boralday, mountains Aksu-Dzhabaglin, Ugamskiy and Karzhantauskiy ranges, as well as in some places of intermountain valleys of Karatau.

Soil-forming rocks are mainly loess-like heavy loam soils and sometimes clays as well as afforested tertiary and chalk clay and sabulous deposits. The ground waters occur at depth and don't influence the soil-formation. There are gray and brown leached, carbonate and normal variants of these soils. They are more or less of the same profile structure, the thickness of humus horizons (A+B) is 60-95 cm, including A' – 20-22 cm. The thickest soils are the leached soils, and the least thick are carbonate ones.

Profile 517 (**Table 5**) (gray and brown leached soil) is situated on the arable land at the distance of 8 km to the S-SE of the village Pervrmaiskoye in Sayram region on the weakly convex surface of ridge connecting the mountains Kazygurt and Karzhantau at the altitude of 1200 m. Effervescence from HCL from 60 cm.

A_{nax} – 0-18 cm. Dark gray, consolidated, slightly soddy, cloddy with grains, heavy loamy.
B_1 – 18-36 cm. Gray and brown, consolidated, weakly slightly soddy, nuciform with grains, heavy loamy.
B_2 – 36-60 cm. Gray and brown, consolidated, nuciform, loamy.
BC – 60-85 cm. Light brown with light humus color, consolidated, nuciform, heavy loamy.
C^{K}_1 – 85-155 cm. Whitish and yellow with many spot and veins of carbonates, consolidated, small-size nuciform, heavy loamy.

Gray and brown soils are characterized with relatively high humus content in comparison with the gray earth (2-3,5%), quite a wide relatio of organic carbon to nitrogen (7-10), relatively great sum of exchangeable bases (15-20 mg per 100g), weakly alkaline reaction of water solutions in horizons of leached carbonates, and alkaline – in carbonate ones, relatively great content of hydrolyzed nitrogen, weak and medium content of mobile phosphorus, medium and great content of potassium. Gray and brown soils are practically free of readily soluble salts. The mechanical content mainly consists of heavy loam varieties with domination of loess-like ones characterized with the large silt particles; there are occasional pebble deposits. The most significant property of the given soils is the great degree of clay accumulation, particularly in the B-horizon. Gray and brown soils are characterized with quite a good content of finer particles and the quantity of water-stable micro-aggregates is 30-65% of the soil weight. These soils are used mainly as good rainfed arable land, with sufficient precipitation for farming of cereals, legumes and fruit trees but in most part there is a need to apply erosion-preventive methods.

The arable land of the given sub-type situated on the slopes are characterized with less humus-content (P 741) (**Table 8**).

8.a. Gray and brown leached heavy loamy soils.

Profile 741 (**Table 8**) is situated at the distance of 300 m to the east from the village Trehsvyatskoye on the higher part of the undulating plain. Farmstead: arable land; vegetation: black barley of the quality below the average. Infestation 3 scores, field birch, centauries. Effervescence from HCl from the depth of 120 cm.

A_{nax} – 0-24 cm. Gray with brown tint, dry, consolidated, heavy loamy, cloddy and granular, lots of plant roots, carbonate-free, worm burrows, lightly foliation at the upper part of the horizon, gradual transition.

B_1 – 24-42 cm. Brown with gray tint, consolidated, heavy loamy, nuciform and granular, worm burrows, fewer roots of plants than in the previous one, carbonate-free, gradual transition.

B_2 – 42-60 cm. Lighter then the previous one, consolidated, heavy loamy, cloddy and granular.

BC – 60-120 cm. Brown with yellow tint, consolidated, heavy loamy, flimsy cloddy, few plant roots, gradual transition.

C 120-188 cm. Pale, fresh, consolidated, very many carbonates in the form of veins, heavy loamy.

Table 8. Chemical properties of arable gray and brown soil on the slopes.

Soil profile #	Genetic horizon	Depth of sampling /cm/	Hygro-scopic moisture %	Absorbed Me/100g of soil			Absorption capacity, (CEC) me/100g	Total		Mobile			Carbonate content %
				Ca	Mg	Na		N	P_2O_5	N	P_2O_5	K_2O	
								%		Mg per 100 g of soil			
1	3	4	5	6	7	8	9	10	11	12	13	14	15
741	A_{nax}	0-10	1,58	17,20	5,30		22,80	0,154	0,186	4,2	38,4	34,3	0,0
		10-23	1,67	13,20	0,60		13,80	0,084	0,202	2,8	38,4	32,0	0,0
	B_1	27-37	1,48	17,20	3,00		20,20	0,084	0,176	2,1	31,2	18,0	0,0
	B_2	45-55	1,18	18,00	3,60		21,60						0,0
	C_1	80-90											27,51
	C_2	170-180											23,73

Table 8a. Mechanical analysis of the grey and brown leached soils

Soil profl #	Genetic horizon	Sample Depth (cm)	Hygro-scopic moistr %	Max hygro-scopic	Size of the particles, mm, quantity, %						Sum of fines <0,01	Soil Texture
					Physical sand			Finer fractions				
					sand		silt			clay		
					0,25	0,25-0,05	0,05 - 0,01	0,01-0,005	0,005-0,001	<0,001		
1	3	4	5	6	7	8	9	10	11	12	13	14
487	A	0-10	2,43	5,60	0,31	6,89	43,20	15,04	17,92	16,64	49,60	Heavy loam
		10-22	2,68	5,09	0,82	3,88	46,62	16,04	15,12	17,52	48,68	-
	B_1	25-35	3,13	6,20	0,32	4,52	4,60	11,48	17,92	25,16	54,56	-
	B_2	44-54	3,25	8,89	0,21	2,15	40,68	13,20	13,68	30,08	56,59	-
	C_1	65-75	3,13	8,24	0,14	3,82	38,16	12,76	18,48	26,64	57,88	-
	C_2	140-150	1,87	7,44	1,42	6,86	49,20	10,48	14,16	17,88	42,52	Med. loam
680	A_{nax}	0-12			1,50	8,02	40,20	14,16	17,16	18,96	50,28	Heavy loam
		12-24			1,59	10,89	40,72	11,20	15,08	20,52	46,80	-
	B_1	26-36			1,24	5,56	43,00	10,28	17,00	22,92	50,20	-
	C	140-150			2,24	4,44	41,60	12,28	16,60	22,84	51,72	-

9. Gray soils

Gray soils in Southern Kazakhstan area occupy medium and lower part of piedmont plains of high ranges of Western Tien Shan and Borolday as well as almost the whole south-western piedmont plain of Northern Karatau and upper part of the north-eastern piedmont plain. Among the gray soils there are subtypes of gray soils ordinary and gray soils light, formed under the influence of vertical climate zones. Each of them in its turn is divided into provincial subtypes of gray soils southern and northern.

9.a.Gray soils ordinary southern occupy the middle part of piedmont plains of the ranges Karzhantau, Ugamskiy and Boralday. Soil parent materials are mainly loessial loams; ground waters are deep and do not affect the soil formation.

Profile 281 (**Table 9**)(Gray soil ordinary southern normal) is situated at the distance of 3 km to the south of Tselina. Density of sward is 80-90%, its height is 15-25 cm. HCl effervescence from the surface.

A_1 – 0-10 cm. Gray, dry, dense, with lots of roots, on top schistous and lamellar, (0-5cm), towards the depth is lumpy, heavy loamy.

A_2 – 10-20 cm. Light gray with brown tint, dry, packed, with few roots, cloddy and granular, heavy loamy.

B_1 – 20-40 cm. Brown and light gray with carbonate mold, dry, packed, with few roots, granular, heavy loamy.

B_2 – 40-55 cm. Grayish and light brown with multiple whitish coating of carbonate mold, dry, packed, granular, heavy loamy.

BC – 55-65 cm. Brown with multiple whitish coating of carbonate mold, dry, packed, granular, heavy loamy.

C^K_1 – 65-120 cm. Pale-yellow with whitish spots of carbonates, dry, dense, low granular, heavy loamy.

Virgin gray soils ordinary southern contain 1,3-2% of humus, 0,09-0,15% of total nitrogen with the ratio of organic carbon and nitrogen amounting to 7,5-10. Carbonate content in the topsoil is 7-14%, in carbonate illuvial layer it is 20-26%. The sum of absorbed bases varies over the range 10-14 mg per 100 g, the absorbed complex contains mainly calcium. The reaction of water soil suspensions is alkali. The content of mobile forms of nutrients in the unfertilized soils is medium – for calcium, medium and low for phosphorus, medium for nitrogen. The given soils are practically not saline and only at a depth of 2m is gypsum found. The mechanical content reveals heavy and medium loamy types almost completely consisting of coarse silt and clay fractions. The soils contain a lot of micro-aggregates, the number of water-stable micro-aggregate in the topsoil amounts to 35-40% of soil weight. Gray soils ordinary southern are widely used for dry farming. This is a dry-farming land with insufficient rainfall and it is necessary to apply agricultural methods for maximum accumulation and conservation of soil moisture, especially those absorbing and retaining water in the surface horizon.

9.b. Gray soils ordinary northern are situated in the upper layer of south-western piedmont plain of the Northern Karatau as well as in the extreme south-eastern low wavy part of the north-eastern piedmont plain of this range. Soil parent materials again are mainly loessial loams. Ground waters do not affect the soil formation. HCl effervescence is observed in all horizons, including the surface horizon. The soils are characterized by a medium thickness of humus layers (A+B = 55-65 cm). According to the chemical and physico-chemical properties these northern gray soils are similar to the southern ones. In the topsoil they contain 1,5-2% of humus, 0,10-0,15% of nitrogen. The relation of organic carbon and nitrogen is 8-9. Carbonate content in the topsoil varies in the limits of 8-18%, and maximum (22-57%) is marked in carbonate illuvial layer (**Table 11**). The absorbed complex is saturated with calcium and to small extent with magnesium. The sum of absorbed cations is not high (7-10 mg per 100 g). The reaction of water soil suspensions is alkali, more intensive towards the depth. The content of mobile potassium compounds is good, phosphorus – low, nitrogen – low and medium. The soil profile has no readily soluble salts at the depth of 2-3 m.

Profile 896 (**Table9**) (Gray soils ordinary northern normal) is situated at the distance of 13 km to the south of the pass Badzhi on the intermountain valley of the Northern Karatau in the medium part of the slanting slope at the absolute altitude of 800m. Density of sward is 60-70 %, the height is 20-40 to 60 cm. Thickness A+B = 55 cm, including A_1 = 12 cm (gray, schistous and lamellar), A_2 = 11 cm (brown and gray, powder-like and granular), B_1 = 17 cm (grayish and light brown, granular). Whitish spots of carbonates in the layer of 55-150 cm. There are readily soluble salts and gypsum down to 220 cm.

The mechanical analysis reveals medium loams, the difference from the southern soils being in a greater proportion of sand and smaller percentage of clay and coarse silt fractions, and a low content or absence of clay accumulation in the topsoil. Gray soils ordinary northern are used for rainfed arable farming. The dry-farming land needs application of agricultural methods to ensure maximum accumulation and conservation of moisture and prevention of rainfall run off. In all cases especially on the eroded land it is necessary to apply fertilizers to compensate for the deficiency of nutrients.

Table 9. Chemical and physical and chemical properties of gray soil ordinary

Profile #	Depth, cm	Humus %	Total N, %	C:N	Ca CO_3	Absorbed cations (me/100g)			pH suspensions		Mobile forms, Mg per 100g		
						Ca··	Mg··	Sum	Water	Salt	hydrolizd nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
9. a. Gray soil ordinary southern normal													
281	0-10	1,7	0,12	8,3	7,0	10,9	0,1	13,8	8,0	-	7,0	2,5	47,2
	25-35	0,9	0,07	7,2	9,6	11,0	0,1	13,6	8,0	-	3,3	0,4	32,0
	45-55	0,7	0,06	6,6	16,4	11,0	0,1	13,4	8,0	-	1,7	weak	23,3
	55-65	0,5	0,05	5,8	19,8	11,0	0,1	15,2	8,0	-	-	-	-
	85-95	0,3	-	-	25,9	7,2	0,1	11,2	8,2	-	-	-	-
9.b. Gray soil ordinary northern normal													
896	0-10	1,5	0,11	7,9	8,0	6,9	0,4	7,3	8,5	-	6,9	1,4	31,4
	12-22	0,9	0,07	7,5	10,5	6,8	0,8	7,6	8,6	-	7,3	weak	20,1
	25-35	0,8	0,07	6,6	12,7	6,7	no	6,7	8,5	-	8,0	-//-	16,7
	40-50	0,7	-	-	19,6	6,8	-//-	6,8	8,5	-	-	-	-

Cultivated rainfed gray soils ordinary are situated on the lower undulating plain. They are formed from loessial loam parent materials under low grass vegetation. High biological activity of the soils and favorable conditions of temperature and moisture in spring aid intensive weathering of mineral substances in the soil. These are carbonate-rich soils that are determined by original carbonate content of the soil parent materials.

At the time of this soil investigation the gray soils ordinary were mainly ploughed and used for cereal and lucerne farming on the dry-farming land.

The morphologic description of the profile #140 is given to characterize the structure of the gray soil ordinary profile. Within the area of investigation, according to the mechanical analysis these soils are divided into:

a) Heavy loamy
b) Loamy.

In heavy loamy soils the content of finer materials in the topsoil (0-35 cm) amounts to 47-52%, (profile # 381). Medium loamy soils differ from heavy loamy in mechanical analysis where the content of finer materials varies within the range 30-45%. Coarse silt fractions dominate in the mechanical analysis (particles 0,05-0,01mm).

The data of chemical analysis reveal that the humus and nutrients content in the two soil types is almost the same. The topsoil (0-10 cm) contains 1,5% of humus, its quantity gradually decreases towards the depth. The similar situation is with humus, nitrogen and total phosphorus, the content of which in the topsoil is: nitrogen – 0,116%, total phosphorus - 0,100%. Carbonate content in the topsoil varies near 4,6%, and downward increases up to 12%. The content of mobile phosphorus is insignificant – 1,93 mg per 100 g of soil, and content of mobile potassium is high – 29,7 mg per 100 g of soil, maximum in the topsoil. The soils are not saline. The data of mechanical content and chemical analysis are given in the **Table 11**.

According to the agricultural and production values they are considered to be arable land requiring application of agricultural methods (B-1 agricultural group).

Profile 140 is situated on the lower undulating plain in the medium part of the slanting slope in the SW. Land: dry plough land. Vegetation: barley. Soil effervescence from HCI from the surface. Soil forming rock type: loess-like loam.

A_{nax} - 0-23cm. Gray, fresh, loamy, weakly packed, cloddy and powder-like, with many roots, visual change of color, structure and density.

B_1 - 23-36 cm. Gray with pale-yellow tint, dry, loamy, packed, granular and cloddy, paths of worms, caprolites, gradual transition of color and structure.

B_2 - 36-57cm. Gray and pale-yellow, dry, loamy, packed, granular and cloddy, paths of worms, caprolites, carbonate mold, gradual transition of color and structure.

C - 57-210cm. Pale-yellow, dry, loamy, residual, concretion of carbonates.

Table 11. Gray soils ordinary heavy loamy. Data of mechanical soil analysis.

Depth of selection, cm	Fraction sizes, mm								
	Sand				Silt			Clay	<0,01
	>3	-1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	0,001	
0-10			0,0	11,88	40,73	14,49	17,02	15,88	47,39
12-22			0,0	11,72	38,69	14,08	20,08	15,43	49,59
25-35			0,0	10,05	37,88	12,57	21,71	17,79	52,07
37-47			0,0	8,69	36,06	12,83	21,93	20,49	55,25
54-74			0,0	9,59	34,13	13,56	24,15	18,57	56,28
80-110			0,0	9,11	36,62	13,05	23,21	18,01	54,27
110-150			0,0	6,49	31,85	20,12	22,97	18,57	61,66
150-190			0,0	8,97	29,37	20,93	23,0	17,73	61,66

Data of chemical soil analysis

#	Depth of selection, cm	Humus %	Nitrogen %	Total phosphorus %	Carbonic acid	Mobile, mg per 100g of soil		Absorbed		
						Phosphorus	Potassium	Ca^{++}	Mg^{++}	Na^{++}
	0-10	1,51	0,116	0,100	4,59	1,93	29,71			
	12-22	1,48	0,110	0,091		0,92	26,20			
	25-35	1,14	0,082	0,073	5,47					
	37-47	1,00	0,073	0,058						
		1			11,76					
					11,48					
					12,10					

Irrigated gray ordinary soils are situated in the more level areas of the low undulating plain. Soil parent materials are mainly loessial loams, and only in small areas - gravelly loam soils underlain with stone layers at depth. Irrigation causes some change in soil formation, as a result of which the biological, chemical and physical properties of the profile are changed.

Irrigated gray ordinary soils are weakly differentiated according to the layers. Ploughed layer the thickness of which is 25 cm is grayish, usually highly sputtered with inclusion of clods and lumps that are solid when dry and are rapidly dispersed due to raindrop action. Under the plough layer the B_1-horizon is characterized with compactness and unity. Towards the depth there is less compacted layer B_2, of gray and pale-yellow color, extensively penetrated with worm channels, with carbonates in the form of silvereye and concretions. Below is given a morphological description.

According to the mechanical content the soils are divided into:
a) heavy loamy where the content of finer fractions in the layer 0-20 cm is 47%, with prevalence of coarse silt (particles 0,05-0,01 mm). (**Table 11**).
b) loamy, where the content of finer fractions in the topsoil (0-27 cm) varies between 34 – 37% with prevalence of fine sandy and coarse silty fractions.
c) loamy on the gravel and pebbles deposits that from the depth of 80-100 cm are stretched under pebble that favors increased filtration property of the soils.

Humus contents in irrigated soils are not high and reach only 1,2%, gradually decreasing with depth. The similar situation is with nitrogen and phosphorus, the content of which in the topsoil is: for nitrogen– 0,09% and total phosphorus - 0,149%. Carbonate layer is not marked and carbonates are evenly distributed throughout the profile and vary within the range 8,5-13,1%. According to the analysis of water extraction, the soils are practically not saline since the value of dense residue in the profile does not exceed 0,091%. The described soils are referred to ploughed lands requiring application of usual zone agricultural methods (B-1 agricultural group).

Morphological description of the irrigated gray soils ordinary: Profile 286. Situated on the lower undulating plain, on the level area. Land: irrigated ploughed land. Vegetation: Lucerne. Effervescence: from 10% of hydrochloric acid from the surface of the soil. Soil parent materials are mainly loessial loams.

A 0-25 cm – gray, damp, loamy, weakly packed, granular and cloddy, with lots of roots, notable transition of color, structure and density.

B_1 - 25-41 cm – pale-gray, damp, loamy, packed, granular and cloddy, worm channels, gradual transition of color, structure and density.

B_2 - 41-61 cm – gray and pale-yellow, damp, loamy, compacted, cloddy, gradual transition of color, structure and density.

C - 61-160 cm – pale-yellow, damp, loamy, residual.

Table 12. Irrigated gray soils ordinary heavy loamy. Data of mechanical soil analysis.

Depth of selection, cm	Fraction sizes, mm							
	Sand			Silt			Clay	Fines
	3-1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	0,001	<0,01
0-20		0,04	15,03	37,75	13,65	15,74	17,79	47,18
30-40		0,18	17,89	35,25	11,84	18,65	16,19	46,68
41-51		0,16	17,96	32,48	14,91	24,84	9,65	49,40
80-90		0,11	15,88	34,78	13,26	16,14	19,83	49,23
100-110		0,08	14,87	36,18	10,92	18,85	19,10	48,87
120-130		0,06	15,59	33,02	11,25	20,45	19,63	51,33
150-160		0,0	8,60	37,87	14,84	27,87	10,82	53,53
210-230		0,0	11,35	37,34	13,44	19,10	18,77	51,31

Data of chemical soil analysis.

Sampling depth, cm	Humus, %	Nitrogen, %	Carbonic acid, %	Mobile phosphorus, mg per 100g of soil	K_2O mg/kg
0-10	1,27	0,107	6,04	3,15	36,0
10-20	1,15	0,094	5,66	2,25	34,0
30-40	0,90	0,081	6,04		
41-51	0,83	0,073	7,06		
80-90			7,39		
100-110	1,04		8,01		
120-130			8,68		

9.c. Gray soils light southern occupy the lower zone of undulating piedmont plains of high ranges of Western Tien Shan and Borolday as well as the extreme southern part of the plain Chardarinskaya. Soil-forming rock types are mainly loess-like loam soil, in the south-western (near Syrdarya river) zone is characterized with light content and in many cases with deep salinity. In the southern part of the plain Chardarinskaya these rock types are ancient alluvial low laminar, sometimes low saline loamy soils. Ground waters are deeper and do not affect the soil formation.

Gray soils light southern are characterized with very weak differentiation of the profile according to the genetic layers, the thickness of humus layers (A+B) varies within the range 40-60 cm, A 13-18 cm, humus content – 1,0-1,5% and nitrogen - 0,06-0,1%. The relation of organic carbon and nitrogen is 8 - 10, content of $CaCO_3$ in the topsoil is 9-13% and increases towards the depth till 18-19% in the bottom part of humus layer. The reaction of water soil suspensions is alkali. Mainly saturated with calcium, small amounts of potassium, very insignificant with sodium. The sum of absorbed cations is 6-10 mg per 100g. Virgin soils are well supplied with potassium, with a good to medium status for nitrogen, and poorly supplied with phosphorus. Content of mobile forms of nitrogen and phosphorus in the ploughed soils is much lower. In the studied soils there are no readily soluble salts; however, in the medium and lower part of the second meter from the surface water-soluble gypsum is found.

The mechanical analysis of gray soils light southern is mainly medium loamy, coarse silty, loess-like, partly consisting of small sand and coarse silt, of lighter texture with depth. The content of clay particles is not high (till 15%). Content of finer fractions is 30-75% of soil weight. Irrigated soils are characterized by smaller contents of humus, nitrogen and mobile forms of nutrients. Areas of gray soils light southern are mainly rangelands, although there are some plots of dry farming situated mainly on the lighter-textured variants of these soils.

Table 13. Analysis of water extraction (%) for air-dry soil

Sampling depth, cm	Alkalinity		CL^-	SO_4^-	Ca^{++}	Mg^{++}	Na^+ K^+ (difference)	Dense residue, %
	Total in HCO_3	Of normal carbonates in CO_3						
0-10	0,030	no	0,006	0,035	0,014	0,004	0,002	0,091
	048		0,16	0,73	0,70	0,30	0,09	
10-20	0,031	-//-	0,007	0,018	0,008	0,004	0,002	0,070
	0,50	-//-	0,20	0,38	0,40	0,30	0,09	
30-40	0,032	-//-	0,008	0,014	0,010	0,002	0,002	0,068
	0,52		0,22	0,30	0,50	0,20	0,09	
60-90	0,033	-//-	0,007	0,022	0,009	0,005	0,002	0,078
	0,54		0,20	0,46	0,45	0,40	0,09	
150-160	0,031	-//-	0,007	0,022	0,009	0,005	0,002	0,076
	0,50		0,20	0,45	0,45	0,40	0,10	
210-230	0,031	-//-	0,006	0,018	0,009	0,004	0,002	0,070
	0,50		0,16	0,37	0,45	0,30	0,10	

Profile 495 (**Table 14**) (Gray soils light southern normal cloddy) is situated at the distance of 13 km to the east of the household «Algabas» in the region Chardarinskiy on the high place of piedmont plain at the altitude of 275 m. Virgin land. Density of sward is 100%, its height is 10-20cm. Thickness of humus layers is (A+B) 50 cm, including A_1 = 13 cm (brown and gray, schistous and cloddy), B_1 = 13 cm (brown and light gray, cloddy), B_2 = 24 cm (grayish and light brown). Excretion of carbonates – whitish spots in the layer of 26-80 cm. White veins and spots of gypsum starting from 150 cm.

9.d. Gray soils light northern are situated in the upper part of the flat north-eastern piedmont plain of the Northern Karatau in the lower zone of south-western analogous plain of this range. Soil forming rock types are represented with loess-like loams of various genesis and lithologic contents, with various tertiary loose deposits, loamy and pebbly gypsum-bearing ancient deposits etc. Ground waters are deeper and do not affect the soil formation. The soils are characterized by weak differentiation of the profiles, the thickness of humus layers varying within the range 40-55 cm. Irrigated gray soils light northern normal usually have somehow increased thickness of humus layers, however humus content in the topsoil is 1,5-1,8 times lesser, as well as feebly marked carbonate and illuvial and compacted under-ploughed layers.

Table 14. Chemical and physical and chemical properties of gray soils light

Profile #	Depth, cm	Humus %	Total N %	C:N	$CaCO_3$	Absorbed cations			PH of suspensions		Mobile forms, mg per 100g		
						Ca··	Mg··	Sum	Water	Salt	Hydrolyzed nitrogen	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gray soils light southern normal													
495	0-10	1,2	0,06	10,6	12,7	8,6	no	8,6	8,1	-	5,5	1,2	40,6
	15-25	0,7	0,04	8,7	14,8	5,1	1,7	6,8	8,2	-	3,4	0,6	42,6
	30-40	0,6	0,03	8,6	19,6	8,5	no	8,5	8,4	-	-	-	-
	60-70	0,3	-	-	17,8	-	-	-	8,5	-	-	-	-
Gray soils light northern normal													
1062	0-10	1,1	0,08	8,0	10,2	6,7	no	6,7	8,6	-	5,3	2,4	42,3
	10-20	0,7	0,05	8,1	11,4	5,0	0,8	5,8	8,4	-	3,1	0,5	43,1
	25-35	0,6	0,04	8,7	12,7	5,0	no	5,0	8,6	-	-	weak	32,4
	45-55	0,6	0,04	8,7	15,7	-	-	-	8,6	-	-	-	-

Profile 1062 (**Table 14**) (gray soils light northern normal) is situated at the distance of 20 km to the N-W of the village Krasnyi Most of Algabass region on the leveled surface of low wavy piedmont plain of the Northern Karatai in the interfluve Chayan and Aksay rivers at the altitude of 330 m. Virgin land. Density of sward is 40-50%, its height is 30-40 cm. Thickness of humus layers is (A+B) 55 cm including A_1 = 10 cm (gray, granular and cloddy), A_2 = 10 cm (brown and light gray, granular), B_1 = 20 cm (grayish and light brown, cloddy and granular), B_2 = 15 cm (lighter, cloddy and granular). Excretion of carbonates – weak mold in the layer of 33-50 cm, rare spots at the depth of 50-130 cm. On the surface there is diversicolored tertiary pebble. In whole gray soils light northern normal are characterized with low humus content (0,9-1,5%) and low nitrogen content in the topsoil (0,03-0,1%), decreasing towards the depth. Relation of organic carbon and nitrogen is quite low (7-9), content of calcium carbonates in the topsoil is 10-15%. The soils are mainly saturated with calcium, partly with magnesium. The sum of absorbed bases is low (6-8 mg per 100g), reducing towards the depth. Alkali reaction. Soil and subsoil layers don't contain great amount of readily soluble salts. Silty (loess-like) and sandy varieties of medium loams prevail in the mechanical content. Plots of the given soils are used mainly as rangelands. In the result of poor rainfalls dry cereal-farming is possible only on granular soils under the condition of thorough accumulation and conservation of soil moisture at the very early period of sowing. More or less satisfactory crops are during the rainy years. Cloddy gray soils are practically not applicable for dry farming. Leveled plots of the given soils under artificial irrigation can be used for cultivation of various food, fodder, fruit and berry and technical crops. Cultivation of early ripening variety of cotton is possible only in the regions in immediate vicinity with the southern gray soils. Irrigated gray soils light usually contain in the topsoil 0,5-0,7% of humus and 0,04-0,09% of nitrogen. Nearly the same amount or a little bit less of these elements is contained in dry ploughed gray soils.

9.e. Irrigated grassland gray soils loamy.

These soils are not widely used. Their total area is 796,86 ha. They were formed like all other soils of the household on the ancient alluvial loess-like saline deposits in the conditions of medium deep (8-10 m) bedding of ground waters under ephemerid motley grass vegetation. Cultivation and irrigation of these soils caused radical changes in the soil formation. Morphological structure of the soil profile, its biological, chemical and physical properties were significantly changed.

In the result of cultivation, the plough layer (30-40 cm) of pale-yellow and grayish color and granular and cloddy structure is formed in the irrigated grassland gray. Under-plough layer differs with compactness and unity. Towards the depth there is less compacted layer of pale-yellow color with fading grayish tint.

For more complete characteristics of these soils below is given the morphological description and averaged values of thickness of genetic layers. Relief – III - above flood-plain terrace of the river Syr-Darya. Micro-relief – not marked. Land – irrigated arable land, soil effervescence from 10% HCl from the surface.

AB_{nax} – 0-35 cm. Pale-gray, fresh, loamy, weakly compacted, granular, silty, cloddy roots, rare worms channels and its caprolites, sharp transition of color, structure and density.

B_2 – 35-52 cm. Light gray with pale-yellow tint, damped, loamy, powder-like and cloddy, roots, inconspicuous silvereye of carbonates, gradual transition of color, structure and density.

BC – 52-72 cm. Pale-yellow with grayish tint, damped, loamy, weakly compacted, porous, powder-like, cloddy, with little roots, gradual transition of color, structure and density.

C_1 – 72-130 cm. Pale-yellow, damped, loamy, weakly compacted, porous, residual, with little roots, gradual transition of color and mechanical content.

C_2 – 150-200 cm. Light pale-yellow, damp, light loamy, thin-porous, residual, with little roots, rust and gley stains.

According to the mechanical content the described soils are medium loams. Content of finer fractions (sum of particles with diameter less than 0,01 mm) in the topsoil varies from 32,5 to 41,0%. According to the grain-size classification there is a prevalence of silt particles (0,05-0,01mm) the content of which amounts to 60% of total sum.

The characteristic of these soils is a clay enrichment of the soil layers in comparison to the parent material i.e. the content of clay fractions (less than 0,001mm) in soil layers is 3-5% more than in the parent material and is 13-15% against 9-11%. First of all, clay enrichment occurs as a result of weathering of primary minerals under conditions of increased moisture and intense biological processes within this layer. Secondly, due to the addition of fine particles to the topsoil through the irrigation waters.

At the depth of 120-140 cm lightening of mechanical content till light loams can be observed where the sum of clay is 22-28%. Lightening of mechanical content is caused by increase of particles of small sand and coarse silt and decrease of particles of small silt and clay. More detailed data of mechanical content are given in the appendix (profiles # 88, 136, 175, 356, 385).

According to the data of chemical analysis the content of humus and other nutrient elements in the described soils is insignificant. In the plough layer there are 0,60-0,80% of humus and 0,050-0,070% of nitrogen. Content of total phosphorus in the same layer varies in the limits of 0,118-0,197%, mobile potassium 160-370 mg/kg of soil.

The quantity of all these elements excluding total phosphorus is reduced sharply towards the depth and in the under-plough layer is: humus - 0,26-0,45%, total nitrogen - 0,028-0,038%, mobile phosphorus - 2-6 mg/kg of soil and mobile potassium - 93-266 mg/kg of soil, i.e. almost twice less than in the ploughed layer.

As it is seen, the grassland gray soils of the household are poor in humus and nitrogen, medium provided with total phosphorus, poor and medium provided with mobile phosphorus and quite rich with potassium (see the profiles # 88, 163, 175, 356, 385 in appendix).

Such low humus and nitrogen content in these soils is explained by the fact that during the irrigation the biology of the soils is radically changed. First of all, this is connected with vegetational change. Cultivated plants take much more nutrients from the soil than natural vegetation. Secondly, irrigation strengthens the biological processes changing the natural moisture.

On the virgin land the decay of vegetative residual material occurs only in spring when the soil is moist, and in summer the microbial activity ceases. On the irrigated plots during continuous moisturizing the activity of soil microbes is strengthened and continues during all vegetation period. As a result not only annual leaves but also accumulated humus substances in the soil are decayed. In this regard irrigated soils are low in humus and nitrogen. Described soils are carbonate ones. Content of carbonic acid of carbonates in the profile varies in the limits of 6-8%. At that level appreciable accumulation in any layer is not observed.

As it is seen from the analysis data of water extraction these soils are not saline with readily soluble salts. Content of dense residual in 2 m layer doesn't exceed 0,300% (see the profiles # 10, 17, 47, 76, 83, 88, 163, 175, 195, 242, 247, 248, 259, 254, 272, 281, 291, 329, 334, 337, 349, 356, 377, 385 in appendix). It is necessary to note that till recent times these soils were also saline as all other soils of the household. Only in the result of multiple leaching applications and high farming standards currently they are not saline. However salinity of lower layers (deeper than 200 cm) and relatively shallow (2-4 m) bedding of mineralized ground waters determine its tendency to secondary salinization.

In general the given soils in the household are lands of good quality and are considered to be of the 1st agricultural and production ameliorative group.

Table 15. Chemical and physical and chemical properties of grassland gray soils.

Profile #	Depth, cm	Humus, %	Total N %	Total P %	Carbon acid	Absorbed cations			pH water		Mobile forms, Mg per 100g		
						Ca··	Mg··	Sum			Hydrol. N	P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
190	0-16	0,84	0,07	0,13	6,04	11,6	5,8	0,00	17,40	8,1	13,2	3,3	25,7
	16-32	0,70	0,06	0,12	7,0	10,4	3,6	0,18	14,8	8,2	10,7	2,8	29,1
	36-46	0,42	0,04	0,10	7,05	7,6	2,4	0,00	10,0	8,4	6,4	0,3	16,6

Grain-size classification of grassland gray soils

Profile #	Sampling depth, cm	Sizes of fractions, mm. Content, % for absolute dry soil									
					>0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
190	0-16	-	-	-	0,0	15,58	46,97	6,57	16,69	14,19	37,45
	16-32	-	-	-	0,0	17,18	44,27	11,09	14,11	13,35	38,55
	36-46	-	-	-	0,0	15,58	47,31	12,69	11,81	12,61	37,11

Water extract (в %) / mg per air-dry soil

Profile #	Sampling depth, cm	Total in HCO_3	Carbonates equivalent in CO_3	Cl^-	SO_4^-	Ca^{++}	Mg^{++}	Sum		$Na^+ + K^+$ by difference	Dense residual %
								Anions	Cations		
190	0-16	0,032	no	0,020	0,058	0,020	0,007	2,28	1,60	0,68	0,142
		0,52		0,56	1,20	1,00	0,60				
	16-32	0,034	-//-	0,016	0,034	0,018	0,003	1,66	1,10	0,56	0,104
		0,56		0,44	0,70	0,90	0,20				
	36-46	0,032	-//-	0,016	0,053	0,018	0,006	2,06	1,40	0,66	0,126
		0,52		0,44	1,10	0,90	0,50				

10. Gray and brown soils

They are formed on the gently sloping plain under wormwood, wormwood and saltwort vegetation. Soil forming rock types are loess-like and often saline gravelly loams on the coluvial deposits (from 1,5 to 5 m). Ground waters are deeper (more than 6 m) and do not affect the soil formation.

Gray and brown soils differ for small soil profile. Thickness of humus layer (A+B) is 30-65 cm. Layer A_1 (0-6cm) represents grayish, very porous peel after which goes light brown schistous layer A_2 (6-15, 6-20 cm). The deeper is brown illuvial layer B (15-30cm), compacted with nut structure, after which goes carbonate illuvial lurid layer B_2 with carbonates in the form of white eyes. Usually from the depth of 60 cm there goes reddish or yellow and brown underlying rock with rare spots of carbonates transited into pale-yellow-brown sandy and pebble deposits. Humus content is 0,6-0,8% with gradual decrease downward the profile. Total alkalinity is not high. Carbonate content is maximum in the topsoil (5-6%), its content decreases notably downward (3,0-0,4%). The soils are poor with mobile forms of nutrients.
According to the mechanical content there are medium and light loamy varieties. Surfaces of the soil are mainly stony. Depending on the particularities of soil forming rocks gray and brown soils are divided into various genetic types.

10.a. Gray and brown ordinary soils – 917,6 ha

The characterized soils in the area of the observed plot are found in the north-eastern and southern part of the rural region. They are formed on the gently sloping plain under ephemeral and wormwood vegetation.

According to the mechanical analysis there are heavy, medium and light loamy varieties (Profiles # 511, 559, 263). Humus content is very low. Humus content in the layer of 0-50 cm of gray and brown soils usually varies from 0,60 to 0,98% (Profiles # 34, 455, 511, 504). The soils contain carbonates throughout the whole profile, but no alkalinity is observed.

Description of morphological properties of gray and brown slightly stony light loamy soils.
Profile 34. Relief – slanting plain. Land – range land. Vegetation – ephemeral and wormwood vegetation. Soil effervescence from 10% HCl from the surface.

A - 0-12cm. Light gray, dry, light loamy, silty, roots, stoney, gradual transition.
B_1 -12-29cm. Brown and light gray, dry, light loamy, residual soil, Some rock material, gradual transition.
B_2 -29-48cm. Gray and pale-yellow with brown tint, dry, light loamy, residual soil.
C -48-82cm. Brown and pale-yellow, dry, light loamy, dense, rock metal, carbonate white eyes.
Starting from 82 cm – coluvium.

The profile is not saline. According to the analysis of water extract (**Table 17**) content of dense residual doesn't exceed 0,094% (profiles # 937, 958). Soil forming rock types are coluvial deposits. The particularity of gray and brown soils is the low ratio of carbon to nitrogen (C:N = 4-5). Absorption capacity is 7-10,85 mg. (**Table 18**). Calcium dominates the absorbed cations. Available forms of nutrient elements are in the following quantity: available phosphorus is 0,61-1,7 mg and available potassium is 15,2-37,2 mg per 100g of soil. Reaction of soil solution is alkali, pH is equal to 8-8,6.

Table16. Mechanical analysis of gray and brown soils.

Profile #	Sampling depth, cm	Sizes of fractions, mm							
		Sand			Silt			Clay	<0,01
		3-1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	0,001	
511	0-10		13,33	44,06	18,51	5,88	12,51	5,71	24,10
	12-22		12,21	52,42	13,76	4,95	10,46	6,20	21,61
	28-38		15,32	42,13	13,74	5,13	10,75	12,93	28,81
559	0-7		9,22	56,69	11,28	8,39	10,56	3,86	22,81
	10-20		9,92	54,83	12,23	2,66	11,39	8,97	23,02
	25-35		10,04	48,07	16,21	5,77	9,31	10,60	25,68
	40-50		13,28	40,86	7,96	7,84	16,00	14,06	37,90
	67-77		15,37	35,19	13,33	7,31	12,32	16,48	36,11
	77-85		46,56	24,99	6,32	2,90	8,45	10,78	22,13

Table 17. Analysis of water extract (%/m for air-dry soil)

19-297-032

Profile #	Sampling depth, cm	Alkalinity		CL”	SO_4 “	NO_3”	Ca··	Mg··	Na”	K’	Sum of salts %
		Total in HCO_3	Standard in CO_3								
1	2	3	4	5	6	7	8	9	10	11	12
937	0-17	0,054		0,003	0,010				1,16	0,90	0,085
		0,88		0,08	0,20						
	20-30	0,105	weak	0,006	0,005				1,98	0,80	0,140
		1,72		0,16	0,10						
	39-49	0,151	weak	0,014	0,005				2,98	0,60	0,210
		2,48		0,40	0,10						
	70-80	0,120		0,011	0,005				2,38	0,70	0,168
		1,96		0,32	0,10						
	110-120	0,059		0,034	0,134				4,72	0,80	0,322
		0,96		0,96	2,80						

Profile #	Sampling depth, cm	Sizes of fractions, mm							
		Sand			Silt			Clay	<0,01
		3-1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	0,001	
263	0-27		0,34	22,63	26,80	16,06	20,20	13,97	50,23
	32-42		0,39	22,31	22,81	12,46	21,46	20,57	54,49
	50-60		0,69	29,00	17,94	12,09	20,29	19,99	52,37
	70-80		4,19	46,25	14,76	8,72	13,18	12,90	34,80
	100-110		2,59	50,61	13,95	6,61	13,22	13,02	32,85

Profile #	Sample depth (cm)	Alkalinity: Totalin HCO_3	Alkalinity: Of standard of carbonates in CO_3	CL"	SO_4"	NO_3"	Ca··	Mg··	Na"	K'	Sum of salts %
1	2	3	4	5	6	7	8	9	10	11	12
958	0-30	0,081	Weak	0,007	0,082				3,22	0,90	0,222
		1,32		0,20	1,70						
	37-47	0,090	Weak	0,0	0,130				4,42	0,70	0,302
		1,48		0,24	2,70						
	60-70	0,100	Weak	0,004	0,118				4,21	0,70	0,291
		1,64		0,12	2,45						
	100-110	0,093	Weak	0,004	0,166				5,09	0,70	0,349
		1,52		0,12	3,45						
	140-150	0,076		0,006	0,130				4,10	0,70	0,280
		1,24		0,16	2,70						
	175-185	0,061	Weak	0,006	0,178				4,86	0,70	0,336
		1,00		0,16	3,70						

Table 18. Chemical and physico-chemical properties of gray and brown desert soils

Prof #	Depth (cm)	Humus %	Total N %	C:N	Ca CO_3 %	Absorbed cations, mg per 100g: Ca··	Mg··	Na"	K'	Sum	pH of water susp.	Mobile mg/100g.: Hydrlzd N	P_2O_5	K_2O
Gray and brown desert non-saline														
34	0-10	0,7	0,06	7,5	4,4	3,9	2,0	0,09	0,4	6,4	8,0	3,6	1,7	37,2
	14-24	0,5	0,04	8,6	4,4	4,6	0,9	0,08	0,3	5,8	8,6	3,4	0,6	28,8
	30-40	0,6	-	-	4,2	5,4	1,4	0,09	0,3	7,1	8,6	-	weak	15,2

Profile #	Sampling depth, cm	Types of analysis: Humus	N	Total P			Carbon acid	Absorption capacity	Absorbed cations	Absorbed sodium	Mobile: P	K
455	0-10	0,77	0,069	0,125				8,2		0,06	0,93	24,0
	16-26	0,50	0,042	0,080								
504	0-10	0,98	0,47	0,138			6,6	6,6		0,09	2,66	37,0
	13-23	0,32		0,091								
511	0-10	0,62	0,60	0,089				7,4		0,07	3,46	32,0
	12-22	0,59		0,043								
	28-38	0,59		0,022								

Description of soil profiles of Southern Kazakhstan

11. Description of soils of the rangeland experimental site «Nalibai».

The experimental tract "Nalibai" is situated on the sands Kyzylkum at the distance of 80 km to the north-west of the central facilities of JSC «Koksu» of Shardarinskiy region of Southern Kazakhstan district. It extends in the coordinates from 41^{0}35'20" to 41^{0}41'47" latitude and from 67^{0}19'10" to 67^{0}26'20" longitude. The total area of the experimental tract is 12.000 ha.

The soil cover of the experimental tract is sand. In contrast to other types of the soil of desert zone (takyrs, gray and brown soils), they are characterized by very low humus-content (<0,3-0,4%), low capacity of absorption (1,5-2,0 mg per 100 g of soil).

The formation of soils proceeds under conditions of physical weathering. Favorable particularity for these soils is its good internal drainage.

Description of the soil profile shows that it consists of 3 horizons:

A 0-17cm - Whitish and yellow mellow (in the layer 0-5 cm united in the flimsy sod) of vaguely arranged structure, mellow sand with multiple small and thin roots, transition is clear concerning the composition.

B 17-54 cm - Light yellow structureless sand, denser, few small and thin roots, there are some big ones, damped, transition is clear concerning the color.

C 54-110cm - Yellow, damper structureless sand, mellow, there are some big roots.

The chemical content of the water extract of desert and sandy soil is shown in the **Table 19**. The sum of water soluble salts varies over the range 0,095-0,08%, that features the described soil as non-saline. The review of the table data shows that the greatest quantity of water extract components is in the upper horizons, that is related to the high absorption capacity. The reaction of soil solution is low-alkaline.

Water properties are given in **Table 20**. The review of the table data shows the greatest values of various categories (maximum absorbability, minimal wilting point). This phenomenon is explained by the fact that in upper horizons there is the greatest % of silt, clay and humus with high absorption capacity. In whole, it is worthy to note that variations of various categories of humidity are not great.

Actual water reserves in the profile and individual horizons in % amount to 43-66,6% of the range of active moisture; the lowest moisture capacity is 39,3-60%.

The low values are observed in the upper horizon (more dried), and maximum values in the low horizons. In whole, the moisture content exceeds the wilting point by 4-6 times. Thus, it is possible to state that at the moment of investigation the complicated favorable water relationships favor the desert vegetation.

Mechanical content and the main physical properties are given in **Table 21**. According to the data of the table, the content of finer fractions varies in the limits of 5,6 % (upper horizons) to 2,4% (in the lower ones). In the top horizons the % of dust and sludge is greater that is stipulated by the particularities of soil formation (processes of physical and biological weathering are more intensive in the top horizons).

The value of bulk density varies in the limits of 1,44 - 1,49, i.e. in upper horizons the soil is less consolidated (more humus-containing), while in the lower – more consolidated.

The value of specific gravity is 2,62-2,65, and variations are not great that is connected with the high homogeneity of mineralogical content and its light weight. The porosity is not high: minimum 44% that is typical for lower horizons (more consolidated), maximum 46% (upper horizon is least consolidated).

12. Description of soils of the experimental site «Syzgan»

The experimental tract «Syzgan» is situated in the territory of JSC «Syzgan» in the sub-mountain part of the Northern Karatau and littoral part of the Moiynkum sands. It extends between the coordinates f44⁰06'58" to 44⁰13'20" latitude. The total area is 12.000 ha.

The soil cover of the polygon «Syzgan» is made of gray and brown, desert and sandy and light gray earth. According to the natural and farming zoning, gray and brown soils are developed in the desert zone in conditions of extreme aridity. Ratio of precipitation to evaporation (hydrothermic coefficient) is less than 0,4. During the year the quantity of precipitation doesn't exceed 90-110 mm. The depth of ground waters doesn't exceed 10-15 m but doesn't affect the soil-forming processes.

The description of the soil profile shows that it consists of the following horizons:

.

Table 19 – Content of water-soluble substances in sandy soils, % and me/litre (experimental tract “Nalibai”)

#	Sampling depth of soil, cm	Sum of salts		Anions								Cations						pH
				CO_3		HCO_3		Cl		SO_4		Ca		Mg		Na + K		
		%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	
1	0-17	0,095	1,3	----	----	0,037	0,6	0,007	0,2	0,024	0,5	0,008	0,4	0,002	0,2	0,016	0,7	8,4
2	17-54	0,073	1,0	----	----	0,031	0,5	0,004	0,1	0,019	0,4	0,001	0,5	0,001	0,1	0,009	0,4	8,0
3	54-110	0,080	1,1	----	----	0,043	0,7	0,004	0,1	0,014	0,3	0,001	0,5	0,004	0,3	0,007	0,3	8,0

Table 20 – Water properties of sandy soils of south-eastern Kyzylkum (experimental tract “Nalibai”)

#	Sampling depth of soil, cm	% of absolutely dry soil			mm of the water column					Humidity content at the moment of investigation	
		МГ	WP	MH	MA	WP	MH	RAM	MH-MA	mm of the water column	% of soil weight
1.	0-17	0,48	0,57	5,60	1,17	1,39	13,70	12,31	12,53	5,38	2,19
2.	17-54	0,44	0,54	4,90	2,40	2,90	26,8	23,9	24,40	17,52	3,19
3.	54-110	0,44	0,52	4,85	5,63	6,66	64,30	57,64	58,67	38,44	4,61
4.	0-20 см	Moisture reserves in soil			1,36	1,6	15,8	14,17	14,51	6,81	2,34
5.	0-50 см				3,32	3,95	37,63	33,53	34,31	21,01	2,85
6.	0-100 см				5,69	7,83	73,77	65,78	67,17	43,46	3,67

Note: ma – maximum absorbability, wp - wilting point, MH – minimal humidity, ram- range of active moisture (mh-wp)

Table 21 – Physical properties of sandy soil of south-eastern Kyzylkum (experimental tract "Nalibai")

#	Sampling depth of soil, cm	Mechanical content (fraction content), %								Sum of fractions		Bulk density of soil, g/cm^3	Specific gravity of soil	Porosity (% of soil)
		3 mm stony	Sand			Dust			Sludge	>0,01	<0,01			
			>3-1 mm large	1-026 mm medium	0,25-0,05 mm small	0,05-0,1 mm large	0,01-0,005 mm medium	0,005-0,001 mm small	<0,001 mm					
1.	0-17	0,00	0,00	12,90	39,97	41,62	1,54	2,15	1,82	94,49	5,51	1,44	2,62	46
2.	17-54	0,00	0,00	20,60	72,47	3,47	0,87	1,16	1,43	96,54	3,16	1,48	2,64	44
3.	54-110	0,00	0,00	18,10	78,29	1,21	0,74	0,80	0,86	97,50	2,40	1,49	2,65	44

A 0-23 - whitish and brown (on the surface there is a stony shell) highly skeletal, lightly damped, flimsy cloddy. There are small and thin roots, transition is clear concerning the composition.
B 23-34 - light brown, highly skeletal, more consolidated, structureless, mellow sand, damped. Sparse and small, somewhere large roots, transition is clear concerning the color.
BC 34-63 - brown, damped structureless, mellow sand. There are highly skeletal contractions, the gypsum transition is clear.
C 63-120 - the same color, composition, highly skeletal, damped, mellow sand. There are many gypsum contractions.

The thickness of humus horizons is 40-40 cm. Humus-content is – 0,3–0,4 %.

The chemical content of the water extract of gray and brown soil is shown in **Table 22**. According to the data of this table, the values of the sum of water soluble salts vary between 0,073 % and 0,66 %, this indicates that the described soil is practically non-saline. Increase of salts in the lower part of the profile are explained by gypsum content (solubility 2 g/l). According to the review data, the dominant value of cations belongs to Na+K, in lower gypsum-containing horizon calcium prevails. In anion content of water extract in the upper horizons hydro-carbonates are prevailing, while in the lower – sulphates (due to content of gypsum). The reaction of soil solution (pH) varies in the limits from neutral to low-alkaline.

Mechanical analysis of the investigated soil is shown in **Table 23**. The review of table data shows that, according to the sum of fractions relating to the finer fractions, the soils are characterized as loose sands. High degree of soil stoniness (starting from the surface) is noted. Stony fractions (more than 3 mm) amount to 35,24 % to 46,54 %. The number of fractions of small sand prevailing in the upper horizon decreases with the transition to the lower horizon from 38,5 % to 14,45 %, while the quantity of large fractions, in opposite, increases. This is explained by the differences of conditions of physical weathering. The value of bulk density in the profile varies in the limits of 1,48-1,75 g/cm3, in the upper part it is somehow smaller that is related to humus content. Its maximum value is in the top horizon, the specific gravity in the profile varies insignificantly in the limits of 2,61-2,68 g/cm3, that is explained by the homogeneity of mineralogical content and low content of finer fractions.

The value of porosity is identified with volume and specific gravity. According to the table data 1, the porosity in the upper part of the profile is smaller than in the lower horizons, that is related to the particularities of desert type of soil-formation.

Water properties of gray and brown soil are given in the **Table 24**. The review of table data shows that there are no significant changes in the profile such categories of moisture as maximal absorbability, wilting point, minimal moisture (excluding the top humus-containing horizon). This is stipulated by insignificant variations of finer fractions affecting the absorbing capacity of the soil. Actual content of moisture at the moment of investigation is 74 - 94 % of the range of active moisture, minimal moisture - 66-81 %. Moisture content is 4-5 times more than the wilting point. Thus, for desert vegetation with powerful roots (70-80 % of the weight of vegetation mass) and high suction force (achieving 40-50 atm) the favorable water regime is formed with sufficient quantity of productive moisture.

13. Studies of erosion of arable gray and brown (dark gray earth) soils.

13.1 Soil and climate conditions.

The studies were carried out on the lands of the ‘seed household Karabau’ of Leninskiy region of Southern Kazakhstan area. The land of the ‘seed household’ is situated in the belt of sub-mountain plain of the western Tien Shan, at an altitude of more than 700 m, representing a number of low watersheds separated by deep and very branched gullies. Such relief in combination with intensive cultivation of slopes creates favorable conditions for water erosion.

According to the data of the special soil and erosion investigation undertaken by Kazgiprozem, 3962 ha out of the total area of agricultural land (4630,7 ha) are exposed to water erosion, i.e. the percentage of eroded lands is 85,5% (**Table 25**).

Table 22 – Chemical content of gray and brown soil (Syzgan)

#	Sampling depth of soil, cm	Sum of salts		ANIONS								CATIONS						pH
				CO3		HCO3		Cl		SO4		Ca		Mg		Na + K		
		%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	%	me/l	
1	0-23	0.073	1.0	-	-	0.031	0.5	0.007	0.2	0.014	0.3	0.01	0.5	0.002	0.2	0.07	0.3	7.8
2	23-34	0.08	14	-	-	0.031	0.5	0.007	0.2	1.019	0.4	0.008	0.4 '	0.001	ОД	L0.014	0.6	7.0
3	34-63	0.10	1.4	-	-	0.031	0.5	0.007	0.2	0.034	0.7	0.004	0.2	0.008	0.7	0.012	0.5	7.2
4	63-120	0,66	10	-	-	0,018	0,3	0,011	0,3	0,451	9,4	ОД5	7,8	0,015	1,2	0,023	1,0	6,8

Table 23 – Physical properties of gray and brown soil (Syzgan)

#	Sampling depth of soil, cm	Mechanical content (fractions content, %)								Sum of fractions		Bulk density of soil g/cm	Specific gravity of soil	Porosity (% of soil volume)
		>3 mm stony	3-1 mm large	1-0,25 mm medium	0,25-0,05 mm small	0,05-0,01mm large	0,01-0,005 mm	0,005-0,001 mm	<:001 MM					
1	0,-23	35,24	18,8	1,70	33,50	2,13	0,77	1,39	0,97	9,37	3,63	1,48	2,61	36
2	23-34	33.21	17.62	7.13	39.02	1.17	0.07	0.92	0.86	98.15	1.85	1.54	2.64	45
3	34-63	44.41	27.32	il-.35	21.31	0.96	0.96	0.41	0.46	98.85	1.15	1.58	2.68	45
4	63-120	46,52	30,74	5,70	14,45	1,21	1,21	1,01	0,24	98,52	1,38	1,75	2,68	35

Table 24 – Water properties of gray and brown soil (Syzgan)

#	Sampling depth of soil, cm	% of absolute dry soil			mm of water column					Moisture content at the moment of investigation	
		MA	K3	MH	MA	WP	MH	RAM	MH-MA	mm of water column	% of soil weight
1	0-23	0.72	0.3	5.3	2.45	2.94	19.74	16.80	17.29	15.99	4.69
2	23-34	0.64	0.77	5.00	1.08	1.39	8.40	7.01	7.32	7.62	4.49
3	34-63	0.60	Ъ.71	4.30	2.17	3.28	21.99	13.71	19.25	14.6	3.18
4	63-120	0.65	0.75	5.00	6Д3	7.41	49.87	42.4	43.69	32.51	3.25
Reserves of moisture in soil				0-20 cm	2.13	2.55	17.1	14.62	15.04	13.9	4.69
				0-50 cm	5.05	6.05	40.34	34.28	35.29	31.7	4.20
				0-100 cm	10,4	12,38	82,57	70,18	72,08	52,81	.3,71

Note: MA - maximum absorbability, WP: wilting point; MH:minimum humidity; RAM:range of active moisture(MH-WP)

The regional climate drastically affects the erosion, in particular the rainfall nature and distribution. To characterize the climate the data of the weather station Leniskoye situated at a distance of 18 km from the household were used. The area has an extreme continental climate. Average annual temperature is +10,1^0, average monthly temperature in July is +25,2^0, in January -4,8^0. Absolute extremes of temperature range from + 42^0 to - 35^0. Average annual rainfall is 483 mm. Maximum rainfall, mainly in the form of heavy showers, occurs in the spring period (April and May).

Snow settles by the end of November and remains till the end of March. The snow thickness is 30-40 cm.

During the investigation years the weather conditions were different. In 1975 the annual rainfall was 413 mm. In 1976 it was 485 mm. 1977 was a droughty year. The rainfall was 389 mm, i.e. less than the norm.

Soils: The top-soil of the lands is represented by dark gray earth forming mainly on the loess and loessial heavy loams parent materials. Morphologic structure of the soil profile is as follows:

A_1 0-10 cm Dark gray, well structured, granular, heavy loam.
A_2 10-20 cm Dark gray, well structured, cloddy, heavy loam.
B_1 20-32 cm light brown, well structured, cloddy with worm channels, heavy loam.
B_2 32-50 cm light brown with white deposits of carbonate veins, well structured, with few roots, heavy loam.
B_3 50-65 cm yellow and brown with white deposits of carbonate veins, weak structure, with few roots, heavy loam.
C_1 65-110 cm yellow and brown with white spots of carbonates, weak structure, medium loamy.
C_2 110-150 cm yellow and brown with white spots, medium loamy.

Table 25. Distribution of eroded lands at the lands of seed household «Karabau» as related to slope gradient

Erosion degree	Total area, ha	Including slope gradients:			
		0-2^0	2-6^0	6-10^0	more than 10^0
Light	2947	459	388	1819	281
Medium	940	-	-	50	890
Strong	75	-	-	5	70
	3962	459	388	1874	1241

In order to develop the correct anti-erosion actions and to determine the volume of soil protection work required, all land of the household was divided into the following groups according to the erosion intensity:

1. Land exposed to water erosion: These areas are characterized with significant thickness of humus horizon $A+B_1$ that is 40-42 cm; humus content in the topsoil is in the limit of 2,5%, nitrogen – 0,17%. Topsoil almost devoid of carbonates which are visible only at a depth of 40-50 cm. These soils are situated on the flatter areas (0-2^0 slopes).

2. Land not exposed to water erosion but potentially susceptible, together with lands exposed to water erosion to small degree 10-20%. The thickness of humus horizon $A+B_1$ is 38 cm, and $A+B_1+B_2$ 52-57 cm. Humus content in the topsoil is in the limit of 1,9-2,0%. Nitrogen content complies with humus content in the topsoil and amounts to 0,151-0,108%. These soils are mainly low in available phosphorus (0,62-0,96 mg per 100 g of soil). The soils of this group were formed in loess-like loam parent materials of heavy texture and are formed on slopes of more than 3^0. In cases of incorrect soil tillage the process of water erosion can occur.

3. Land exposed to water erosion to a low degree. The thickness of humus horizon A+B is equal to 50-55 cm. The surface water flow from this topsoil carries away a great amount of matrix and along with it humus and nutrients that results in reduction of strength of soil structure micro-aggregates and to some weakening of the soil structure. Humus content in the topsoil is half lower than in the non-eroded soil (1,7-1,8%). The available phosphorus content is very low 0,65-0,67 mg per 100 g of soil, and potassium content is very high 37-50 mg per 100 g of soil.

4. Land exposed to water erosion to a medium degree together with some land exposed to water erosion to a small degree (20-30% of area). The plot where our experiments are carried out refers to this group. The thickness of the humus horizon A+B amounts to 40-50 cm; the topsoil A is almost completely washed away. And at the surface is gray and brown horizon B with weak cloddy and dispersed structures. According to the mechanical analysis the soil is a heavy loam. Humus content is 1,55-1,75% and carbonate contents in the topsoil are high. The total nitrogen amounts to 0,100-0,113%.

5. Land exposed to water erosion to a great degree. The thickness of the humus horizon A+B amounts to 20-30 cm, the horizon «A» is almost completely washed away and so is partially horizon «B». To prevent further development of water erosion and to increase its fertility, the eroded soils require special soil conservation measures.

13.2. Result of Studies: To develop agricultural methods for spring grain crops on slopes exposed to water erosion.

Surface water flow and surface wash: Surface water flow and surface wash depends on slope gradient, frequency and intensity of spring rains, and most critically the method of tillage on the sloping land. In the framework of our investigations during the melting of snow there were no water flows and surface wash on the tilled slope.

On the experimental watersheds it was discovered that the formation of surface water flow and surface wash depends mainly on spring showers. On the soil of the tilled slope the surface water flow generated by the rainfall varies over the three year period from 3,4 mm to 13,7 mm per year, the soil surface wash from 0,37 to 2,9 t/ha. According to the data, among all tested methods of anti-erosion soil tillage the most efficient turned out to be flat-cut tillage to a depth of 28-30 cm, subsurface tillage to a depth of 28-30 cm, + diking and flat-cut tillage to the depth of 28-30 cm. All kinds of tillage to the depth of 0-22 cm turned out to be less efficient in the measures against water erosion.

Dynamics of soil moisture. In the conditions of dry farming the determinative condition for high and sustainable yields of agricultural crops is soil moisture.

The conducted experiments evaluated the water regulating techniques of soil tillage. The tillage techniques that turned out to be the most efficient in erosion prevention led to the greatest increase in accumulated available soil moisture. The data of this table shows that during the period of germination, the reserves of productive humidity in the top 1,5 m layer in all cases where plowing was undertaken to a depth of 28-30 cm was higher than in the cases where tillage was carried out only to a depth of 20-22 cm. The maximum amount of available soil water was in the case of subsurface tillage + diking. This means that deeper tillage, flat-cut tillage and diking promote movement of some part of surface runoff into the deeper parts of the soil profile.

Dynamics of nutrient contents of the soil. The particularities of nutrient content of eroded soils are discussed in the proceedings of N.K.Shikula (1963), M.K. Zaslavskiy (1966), L.I. Akentyeva(1969) and others. They note that along with the increase of erosion degree the content of nutrients in the soils is decreased.

According to the data, it is evident that among the choices of slope land tillage the highest content of nitrates is observed at the plots of subsurface tillage to a depth of 28-30 cm + diking, flat-cut tillage to the depth of 28-30 cm + leaching and flat-cut tillage to the depth of 28-30 cm.

The study of dynamics of available phosphorus in the topsoil also depends on the techniques of the soil protection tillage of the sloping lands. However, according to the content of exchangeable potassium there is no connection between K20 and techniques of soil tillage.

Water permeability. The rate of water movement through the soil profile depends on its water permeability, i.e. ability to accept and to pass water (soil infiltration rate and unsaturated hydraulic conductivity).
It is known that water erosion occurs only in the case when rainfall exceeds the rate of water permeability into the soil. If water permeability significantly exceeds the intensity of rainfalls then there will be no surface runoff and therefore no erosion.

Each factor reducing the water permeability increases the surface runoff. Good water permeability favoring deep rainfall penetration has great significance for deeper rooting of the plants and improves nutrient content of the soil. Considering the poor soil structure, the water permeability of dry gray earth is extremely important.

As is evident from the data, water permeability varies depending on the kind of the main tillage carried out. Comparatively higher water permeability was noted with the deep flat-cut tilled areas. It shows that the soil structure and water permeability were improved during the second and the third years of flat-cut tillage on the same land plot. The reason for low water permeability during the subsurface tillage is residual soil, compaction of the topsoil and silt accumulation in the water conveyance channels of the soil.

Available Water Holding Capacity (AWHC). Available Water Holding Capacity is the most important characteristic of the water properties of the soil. At high moisture capacity in the soil there is maximum amount of moisture available for plants. AWHC depends mainly on the mechanical analysis of the soil and humus content. The AWHC of the studied moderately eroded soil is 23-27%.

Yield of spring barley on the washed out soils. The results of our investigations showed that the techniques of the main tillage greatly affected the crop yield. In average during the three years the yield of the spring barley on the experimental land plot (moulded tillage) was 13-14,0% more for subsurface tillage.

14. Soil organic matter (humus) status, and soil carbon stocks

Table 25. SKO Soils, soil organic matter status, and soil carbon stocks

Soil Type:	Page	Humus % (A-hor)	Tonnes C / ha	MAR (mm)	Elev(m)
Mountain soils	1				
1. Mountain meadow and steppe alpine and sub-alpine soils	1				
1.a. Mountain meadow and steppe alpine immature soils	1	0,4	27	>>800	3700
1.b. Mountain meadow and steppe alpine normally developed soils	2	9,1	162	>800	2820
1.c. Mountain meadow and steppe sub-alpine soils	2	12,9	244	>800	2250
2. Mountain and steppe alpine and sub-alpine soils	3				
2.a. Mountain and steppe alpine normally developed soils	3	2,8	64	>800	3340
2.b. Mountain and steppe sub-alpine soils	3	5,9	73	>800	2500
3. Mountain and meadow hydromorphic alpine and sub-alpine soils					
3.a. Mountain and meadow hydromorphic alpine, illuvial and humus acid soil.	5	35	750	>>800	3370
3.b. Mountain and meadow hydromorphic sub-alpine acid soils	5	9,5	160	>800	2350
4. Mountain brown soils	5				
4.a. Mountain dark brown normal soils	5	8,4	205	>800	2100
4.b. Mountain light brown soils (carbonate)	5	4,6	121	>800	1450
5. Mountain gray and brown soils	6	3,2	93	>700	1000
6. Mountain gray earth.	6				
6.a. Mountain ordinary gray earth	6	1 ,5	39	170-250	700
6.b. Mountain light gray earth	7	0,8	9	170-220	350
Soils of intermountain plains, sub-mountain and other high & low plains	8				
7. Brown soils	8	4 - 7	75 - 115	600-800	1200-1600
7.a. Brown leached, normal and carbonate	8	4,1	118	600-800	1200
7.b. Brown light leached	8			600-800	
7.c. Brown leached heavy loamy soil	9	5,0		600-800	
8. Gray and brown soils		2,0 – 3,5			
8.a. Gray and brown leached	10	2,5	80	400-700	1200
8.a. Gray and brown leached heavy loamy soils	10			400-700	
9. Gray soils		1,3 – 2,0	32 - 48		800
9.a.Gray soils ordinary southern	11			200-400	
9.b. Gray soils ordinary northern	11	1,5 – 2,0		200-400	800
9.c. Gray soils light southern	15	1,0 – 1,5	27 - 29	200-400	275
9.d. Gray soils light northern	16	0,9 – 1,5		200-400	330
9.e. Irrigated grassland gray soils loamy	16		21	200-400	c250
10. Gray and brown soils	18	0,6– 1,0	10 – 14	200-400	
10.a. Gray and brown ordinary soils	19			200-400	c250

Table 26. Calculation on Soil Organic Carbon Stocks represented by SKO Soil Types

Soil Nos.	Soil Type	Tonnes C / ha	Ha	Total Soil C Stocks (million tonnes)
1 – 6	Mountain Soils	130	895.000	116
	Soils of Inter-mountain plains, sub-mountain & low valleys:			
7, 8	Dark brown, Grey & brown	100	782.000	78
9a, 9b	Grey earth ordinary (southern & northern)	40	1.021.000	41
9c, 9d	Light grey earth (southern & northern)	28	967.000	27
9e	Meadow grey earth	21	636.000	13
10	Soils of desert plains (grey and brown etc)	12	2.391.000	29
Other	Other desert soils, and Miscellaneous Land Types etc	5	4.219.000	21
TOTALS:		**Avg: 29,8**	**10.911.000**	**325**

Annex D: Irrigation Statistics by Rayon, comparisons 1987-2004

IRRIGATED AGRICULTURAL AREAS (Ha), PRODUCTION AND YIELD PER Ha for 2004

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AREA	Parameter		Area Total	Grain	Industrial Crops Total	Industrial Crops Cotton	Industrial Crops Oilseeds	Potatoes,Veg,etc Total	Potatoes	Vegetables	Pumpkins & Gourds	Fodder Crops Total	Fodder Maize	Annual Leys Total	Annual Leys Hay	Annual Leys Grzng	Peren.Leys Total	Peren.Leys Hay	Peren.Leys Grazng	Natural Pasture	Fruits, Raisins, and Berries	Fruits & Berries	Fruits	Berries	Raisins
Total SKO	Harvested	Area(000Ha	**343,7**	**43,1**	**226,0**	214,8	10,9	**26,6**	3,7	10,8	12,1	**47,9**	1,7	1,5	*1,4*	*0,1*	44,6	*40,7*	*3,9*	**4,8**	**8,2**	5,6	*5,6*	*0,0*	2,6
	Productn	*(Tonnes)*		***121,7***		*454,9*	*14,7*		*54,6*	*207,1*	*194,1*		*32,5*		*1,4*	*0,7*		*235,3*	*38,1*	**21,9**	**36,5**	14,9	*14,8*	*0,1*	21,6
	Yield	(centner/ha)		**28,2**		21,2	13,5		147,4	192,2	160,8		195,2		*10,0*	*74,8*		*57,8*	*98,3*	**46,0**	**44,1**	26,4	*26,4*	*41,2*	82,1
Shymkent	Harvested	Area(Ha)		668,0	**4,5**	4,5		**244,2**	19,3	222,9	2,0		3,0					*934,3*				17,0			5,0
	Productn	*(centner)*		*3732.8*		*55,8*			*1129,0*	*16986,6*	*300,0*		*3,0*					*7853,0*				69,0			50,0
	Yield	(centner/ha)		5,6		12,4			58,5	76,2	150,0		1,0					*8,4*				4,1			10,0
Arys	Harvested	Area(Ha)		328,0	**4684,0**	4612,0	72	**607**	24,0	100,0	483,0							*1130,0*				10,0			
	Productn	*(centner)*		*9139*		*74122,0*	*1116*		*2930,0*	*9722,0*	*63414,0*							*46084,0*							
	Yield	(centner/ha)		27,9		16,1	15,5		122,1	97,2	131,3							*40,8*							
Kentau	Harvested	Area(Ha)		303,3	**532,7**	439,7	106	**119,1**	4,5	82,1	32,5							*186,3*				62,0			
	Productn	*(centner)*		*3241,0*		*6370,0*	*465*		*248,0*	*9122,9*	*1435,0*							*6554,7*				179,0			
	Yield	(centner/ha)		10,7		14,5	4,4		55,1	111,1	44,2							*35,2*				2,9			
Turkestan	Harvested	Area(Ha)		4506.5	**22524,8**	21843,5	681,3	**2188,9**	164,5	472,7	1551,7							*7018,4*		4767		195,7			12,4
	Productn	*(centner)*		*130175,5*		*576706,0*	*7129*		*24977,0*	*111764,0*	*258506,0*							*479239,0*		219366		6992,0			625
	Yield	(centner/ha)		28,9		26,4	10,5		151,8	236,4	166,6							*68,3*		46		35,7			50,4
Baidibek	Harvested	Area(Ha)		1066,5	**1186,2**	1023,0	163,2	**710,5**	198,6	229,3	282,6							*23,0*				22,0			
	Productn	*(centner)*		*36311,0*		*15453,5*	*1469,5*		*15053,2*	*16390,4*	*23186,2*							*190,0*				717,0			
	Yield	(centner/ha)		34,1		15,1	9		75,8	71,5	82,0							*8,3*				32,6			
Kazygurt	Harvested	Area(Ha)		967,5	**1615,2**	410,7	1276,5	**2215**	664,7	1009,3	541,0							*1089,0*				820,4			59,5
	Productn	*(centner)*		*24071,0*		*7985,0*	*13696,1*		*107146,0*	*242627,0*	*94311,0*							*45305,0*				10724,0			830
	Yield	(centner/ha)		24,9		19,4	10,7		161,2	240,4	174,3							*41,4*				13,1			13,9
Maktaaral	Harvested	Area(Ha)		3086	**121553**	121243,0	310	**2801**	61,0	892,0	1848,0		1076,0					*2449,0*	45			14,0			383
	Productn	*(centner)*		*102628,0*		*2393350,0*	*8550*		*6470,0*	*114170,0*	*178140,0*		*231580,0*					*270589,8*	11250			695,0			47423
	Yield	(centner/ha)		33,3		19,7	27,6		106,1	128,0	96,4		215,2					*110,5*	250			49,6			123,8
Ordabasy	Harvested	Area(Ha)		3357,5	**15437**	12565,9	2871,1	**2113,1**	338,8	882,9	891,4							*2609,1*				5,0			78
	Productn	*(centner)*		*88774,8*		*274553,3*	*30696,6*		*59181,3*	*191229,5*	*162960,0*							*129532,5*				990,0			4320
	Yield	(centner/ha)		26,4		21,8	10,7		174,7	216,6	182,8							*49,5*				198,0			55,4
Otyrar	Harvested	Area(Ha)		2447,5	**11187,1**	10863,0	324,1	**576,8**	14,5	97,7	464,6							*2479,6*							
	Productn	*(centner)*		*83577,0*		*213740,2*	*4868,5*		*941,4*	*7809,3*	*45309,0*							*151437,0*							
	Yield	(centner/ha)		34,1		19,7	15		64,9	79,9	97,5							*61,1*							
Sairam	Harvested	Area(Ha)		10122,2	**694,5**	77,0	617,5	**3440,2**	514,7	2740,2	185,3		213,0		1,0	94		*4711,0*	3835			1236,2			520,7
	Productn	*(centner)*		*287865,5*		*1591,0*	*5594,6*		*70989,3*	*617262,9*	*39091,1*		*34775,0*		*15,0*	*7027*		*168882,0*	470053			48786			31920
	Yield	(centner/ha)		28,4		20,7	9,1		137,9	225,3	211,0		163,3		15,0	74,8		*35,8*	96,5			39,5			61,3
Saryagash	Harvested	Area(Ha)		8452,6	**13697,8**	10363,7	2937,1	**6973**	1317,8	2966,0	2689,2							*4082,4*				351,6			1161,4
	Productn	*(centner)*		*259387,0*		*250600,0*	*54195,7*		*210888,9*	*554894,0*	*488272,5*							*260938,0*				18786			98781
	Yield	(centner/ha)		30,7		24,2	18,5		160,0	187,1	181,6							*63,9*				53,4			85,1
Sozak	Harvested	Area(Ha)		1131,6	**146,3**		146,3	**283**	105,0	70,5	107,5							*1446,1*				79,5			
	Productn	*(centner)*		*19849,0*			*1029*		*9686,0*	*6105,0*	*10910,0*							*31859,0*				775,7			
	Yield	(centner/ha)		17,5			7		92,2	86,6	101,5							*22,0*				9,8			
Tolebi	Harvested	Area(Ha)		40,8	**163,9**		163,9	**445,9**	174,6	271,3								*2905,0*				1296,5			18
	Productn	*(centner)*		*1019,6*			*2780*		*26058,0*	*53076,0*								*188580,0*				24276			400
	Yield	(centner/ha)		25,0			17		149,2	195,6								*64,9*				18,7			22,2
Tulkibas	Harvested	Area(Ha)		3282,9	**265,8**		265,8	354,3	36,5	317,8								*2052,2*				1479,8			387,3
	Productn	*(centner)*		*80703,0*			*2204*		*3966,0*	*58642,0*								*56648,0*				35440			31771
	Yield	(centner/ha)		24,6			8,3		108,7	184,5								*27,6*				23,9			81,4
Shardara	Harvested	Area(Ha)		3354,5	**32229,1**	31304,1	925	**3480,4**	64,5	420,0	2995,9		373		1374,3			*7624,5*				59,7			5
	Productn	*(centner)*		*86035,0*		*734828*	*12817*		*6200,7*	*60940,0*	*575252*		*58640*		*13718*			*509727,0*				917			75
	Yield	(centner/ha)		25,6		23,5	13,9		96,1	145,1	192		157,2		10			*66,9*				15,4			15

Annex E: Legal Aspects

Legislation of the Republic of Kazakhstan in the field of environmental monitoring and auditing (with regard to sustainable land use)

To regulate land relations in the agricultural sector and to motivate the use of agricultural lands as well as the conservation of land fertility, on the 20th of June 2003 the Land Code of the Republic of Kazakstan was approved (further in the text LC RK).

LC RK became an important legislative enactment in the field of land relations control and is a result of codification of all land legislation with inclusion of all main land laws. All basic issues relating to the land use in agriculture are governed by the LC RK. Some not basic provisions including those relating to the rangeland management are detailed in the governmental regulations. In this regard the given review of the land legislation on rangeland use is based on the standards of the LC RK.

Legislation /Strategies relating to the agricultural land use	The basic principles – what is stipulated by the law	Gaps, problems, ambiguities in certain situations
Land Code RK	Stipulates environmental, sanitary and hygienic, and other special requirements to designing and commissioning of buildings (structures, constructions) and other objects making impacts on land conditions**.** In particular, it is provided that in case of allocation, designing and commissioning of new and reconstructed buildings (structures, constructions) and other objects, in case of commissioning of new equipment and technologies negatively affecting the condition of land, the land protection activities should be undertaken, the observation of environmental, sanitary and hygienic and other special requirements (norms, rules, standards) should be ensured. Assessment of negative impact on land condition and of efficiency of activities for its protection is made based on the results of the **State Environmental Examination**, other state examinations, without approval of which it is impossible to implement new equipment and technologies, to realize land amelioration programs, to finance construction (reconstruction of buildings and other objects).	General requirements that relate to all categories of land. It is necessary to detail them according to the type of agricultural land use.
Law of the RK of July 3, 2002 # 331-II «On plant protection»	Regulates the application of pesticides (insecticides). Its application to the rangeland (pastures) should be in compliance with the technology of efficient and safe use set in the list of pesticides (insecticides) permitted at the territory of the Republic of Kazakhstan. It is prohibited to leave unused pesticides (insecticides) in the field, but keep them at specially designed places for temporary storage.	No specific requirements to the application of pesticides (insecticide) in agriculture. The practice of pesticides application on the agricultural lands is not studied. This should be done concurrently with the inventory of these lands and compilation of cadastral data. This has not done yet.

Legislation /Strategies relating to the agricultural land use	The basic principles – what is stipulated by the law	Gaps, problems, ambiguities in certain situations
Environmental Code RK of January 9, 2007	Establishes the following requirements: - during the transportation, storage and application of plant protective stuffs, mineral fertilizers and other chemicals used at the territory of pastures (rangelands), persons and legal entities must observe rules of transportation, storage and application of the listed stuffs and undertake preventive activities for protecting animals from illness and death. - it is prohibited to leave treated seeds on the surface of the soil on the pastures and rangelands available for wild animals.	Environmental Code doesn't contain requirements to agriculture. It contains general environmental requirements that only indirectly relate to the use of agricultural lands. The incentives for environmental improvement of the lands, enhancement of its fertility and production of environmentally clean food are not stipulated.
Chapter 31EC RK	Zoning of agricultural lands is based on the indicators of severity of environmental problems, the criteria of which are physical degradation and chemical contamination. The identification of chemical contamination level of rangelands is done on the basis of maximum allowable concentrations of chemical substances in the soil that authorised by the state bodies responsible with environmental protection and sanitary epidemiological protection of the population. Environmental criteria for land assessment for: identifying whether it should be considered as more valuable or less valuable; land conservation; attributing land to the environmental disaster zone or zone of environmental emergency. These criteria are ratified by the regulation of the Government of the Republic of Kazakhstan of June 7, 2007 #581	This regulation establishes the criteria of environmental condition of residential areas; this is not stipulated for the agricultural lands. It contains general criteria namely wind and water erosion of soils, man-caused (operational) degradation, physical (agricultural) degradation, agricultural soil depletion etc.
Regulation of the Government of the Republic of Kazakhstan on ratification of Rules of land conservation. September 29, 2003 #993	When it is impossible to recover soil fertility of degraded agricultural lands, lands contaminated with chemical, biological, radioactive and other hazardous substances, land contaminated by industrial and domestic wastes and sewage waters above the standards, and as well lands infected with quarantine pests and plant diseases, then the measures of land conservation are applied i.e. lands are temporary excluded from the use. Identification of such lands is done by local authorities, territorial oblast departments for land management (city of republican importance), environmental protection and other authorized offices in the framework of state control of land use and protection or as a result of field.	Reasons of degradation and contamination of agricultural lands that eventually lead to land degradation are considered by the special commission. In case of guilt of the landowner (land user), he is imposed with administrative penalty. And compulsory withdrawal of the land and reparation of damages caused by environmental pollution are considered.

Legislation /Strategies relating to the agricultural land use	The basic principles – what is stipulated by the law	Gaps, problems, ambiguities in certain situations
	The period of conservation of degraded, contaminated and damaged lands as well as lands infected with quarantine pests and plant diseases is approved on the basis of commission conclusion depending on the qualitative condition of the lands. Land plots subject to conservation are withdrawn from the owners or land users for a period of its conservation in compliance with the civil legislation and are transferred to the reserve lands of corresponding executive authorities. Losses incurred by landowners and land users relating to the land conservation are reimbursed according to provisions of Land Code.	It is necessary to stipulate the obligation of the landowner (land user) to implement agricultural methods and meet amelioration standards and requirements. This is not stipulated in the existing legislation. There are no regulations regarding the responsibility of the state when the state is guilty for agricultural land degradation. There is a reference to the standards of civil legislation for this case.
Chapter 31 EC RK	**The article 216 stipulates environmental requirements for optimal land use, among which are** - provision of specific land use and preservation of valuable agricultural lands; - formation and positioning, according to good environmental management practises, compact optimal-sized land plots; - development of measures for improvement of agricultural lands, increase of land fertility, maintenance of sustainable landscapes and land protection; - development of activities for rational land use and protection; - to make a land inventory and identify any unused, or inappropriately used lands and lands used out of purposes; For construction of not-agricultural objects **should be allocated lands unfit for agriculture with the lowest bonitet.**	There is no procedure on how to implement this.
Government decree of the Republic of Kazakstan of January 5, 2005 # 3 « On the program for rational agricultural land use during 2005-	Works on improvement of rangelands of Kazakhstan include: Development of activities for territory management and implementation of haymaking and rangeland rotations, fundamental and superficial improvement of low-productive hay-fields and rangelands as well as reconstruction of irrigation structures and irrigation of rangelands, possessed by business entity and at the reserve territories provided for its further use.	There is no state and public control of realization of the State programs. The given programs have no legal force as laws and other standard acts. This Program doesn't detail the list of activities for restoration of agricultural lands. In its framework it doesn't stipulate the ratification of any special standard acts.

Legislation /Strategies relating to the agricultural land use	The basic principles – what is stipulated by the law	Gaps, problems, ambiguities in certain situations
2007»	Development and practical implementation of environmental standards for optimal land use.	The environmental standards of optimal land use are not developed.
Govmnt. decree of the RoK of Jan 24, 2005 # 49 'On the program for combating desertification in the Republic of Kazakhstan during 2005-2015'	During the first stage (2005-2007) the following issues are stipulated: - To work out the inventory and assessment of condition of lands exposed to desertification; - To implement pilot projects for land restoration or prevention of its degradation; - To rise public awareness and involvement of population in the decision making process regarding issues of combat against desertification.	The inventory and assessment of condition of lands exposed to desertification are not completed. There is lack of information available for local population because the legislation (neither LC RK, nor EC RK) doesn't stipulate the forms, frequency and methods of delivery of such information.

The study of the existing land legislation concerning the land management reveals that there are no special legal norms regulating in detail the particularities of use of individual type of agricultural lands that in practice contributes to their irrational use. There are no special state (national), regional programs for protection (restoration) and use of rangelands.

The reasons of incorrect application of law are explained by general (non-committal) legal instructions and absence of clearly stated legal procedures in the field of protection and use of agricultural resources. In present time there is a trend of dissociation and absence of efficient and close cooperation between departments, Ministry of Agriculture RK and Agency for Land Management RK that affects the solving of the problems and inactivity of local state authorities which are not given recommendations, consultations in all spheres of agricultural production.

Existing legislation doesn't allow close and effective cooperation of various state and public institutions regarding land management in the agriculture. Local governments in rural areas don't work effectively. This is connected to the fact that the legislation doesn't regulate the limits and conditions of their activity in detail, only in general. So far the law 'On local self-government' is not ratified yet. In LC RK there are no provisions regarding local community rights to participate in activity on regulation of land relations. In my opinion, this would give the opportunity for involving population in decision making process of land issues, get access to projects for land management and schemes of territorial zoning, to make personal suggestions, to control the execution of intended plans, programs for land protection and use, actively participate in the process of provision and withdrawal of lands, to require reports for the decisions made. This will make state officers to consider the needs and requirements of the local population.

Improvement of legislation in the field of land management in agriculture should be done as follows.

1) Monitoring of lands and other natural resources is conducted by means of the uniform system at the whole territory of the Republic of Kazakhstan by the specialized state enterprises, which according to the existing legislation are business entities with the status of commercial organizations. All information received in the course of monitoring is legally a state property and in fact their property which they

unwillingly share with other interested organizations. MEP, Agency for Land Management RK and other state authorities fulfill the control functions with no right to give or to receive free information that leads to departmental dissociation concerning information exchange, to failing to realize Governmental decisions, President's orders etc. It is necessary to review the legal status of the state enterprises ensuring the conduction of monitoring, cadastre of natural resources etc.

- It is necessary to develop Rules for information exchange received in the course of environmental monitoring and use of individual natural resources and to ratify them by means of special Governmental regulation which should detail the amounts, conditions and term of environmental monitoring data exchange as well as the responsibility of the individual state authorities and state enterprises hindering the access to complete and timely information.

2) In the land legislation there are no economic procedures for practical use and protection of agricultural lands. This needs detailed elaboration.

- To prevent the desertification and degradation of lands it is necessary to develop procedures ensuring: natural and environmental zoning on the basis of lanscaping approach;
- Development of soil-protection crop rotations and rangeland rotations ensuring the restoration of soil fertility along with the optimal use of chemical and biological methods;

3) Existing legislation is being developed in the direction of general regulation of functions and authorities of all state offices that in practice causes irresponsibility of the state officers concerning the land issues. Therefore, it is necessary to indicate not only rights but also obligations of the state offices.

4) To make information on land publicly accessible, it is suggested to include in the LC RK a requirement on annual publishing of reports (summary data) on land conditions in mass media that will be an effective action for public control of the activity of authorities and government.

5) The practice shows that agricultural producers don't receive permissions for special nature consumption including emissions. It is necessary to ensure the meeting of environmental norms and requirements to agriculture in the following way:

- To stipulate an individual chapter in the Environmental Code RK entitled 'Environmental requirements of agricultural activities' which would stipulate required procedures to ensure the principles of the production of environmentally clean agricultural products, and sustainable and practical use of land, water and other resources.

To ensure the coordination of activities of the MoEP RoK, Ministry of Agriculture RoK, Agency for Land Management RoK for solving environmental problems of land use.

Annex F: Carbon Sequestration and Stocks: the Kyoto Protocol

Points of discussion from 4th Project Workshop, 23rd October, 2007:

The Global Problem:

- Fossil fuel burning / cement production currently generates CO_2:	**6,3 billion tons C/year**
- Land use changes (cultivation/deforestation)	**1,6 billion tons C/year**

The above fluxes are represented by increases in CO_2 stocks in the following areas:

- Increase in atmospheric-C:	**3,2 billion tons C /year**
- Increase in oceanic-C:	**2,3 billion tons C/year**
- Increase in terrestrial-C:	**2,3 billion tons C/year**

Within the Agricultural and Land Sector there are possibilities for increasing the C stocks through improved management techniques. Estimates for potential additional C sequestration are the following:

Soil C:	**0,9 billion tons C/year**
Forest trees/bush/grassland vegetation:	**1,5 billion tons C/year**

The Kyoto Protocol:

Article 3.3 covered: **afforestation, reforestation, deforestation**

Article 3.4 covered: **C-sequestration in croplands, grazing lands, managed forests, land subject to re-vegetation**

Biospheric sinks and sources: **comparison between 1st commitment period: 2008-12 with baseline (1990) emissions.**

Marrakech Accords, 2001: **accounting on a net emissions basis.**

Major problems with Kyoto (& current situation):

- major polluters were not on-board: USA, China, India, Australia

- measures being taken by the signatory countries were less effective than really necessary

- EU countries were the most active, but too many tradable permits were issued

- economics, and legal, environmental and planning problems with alternatives (e.g. nuclear, wind, wave, tidal)

- Governments not yet ready to implement Carbon Tax and Credit measures.

But current major worries on rate of glacier melting, rise in sea level, correlated with accelerated emissions of CO_2 and rise in atmospheric CO_2 levels

Size of Soil-C sinks:

Chernozem, Russia:	**native grassland:**	**462tons C/ha**	**46,2kg/sq m**
	Long-term arable:	**387tons C/ha**	**38,7kg/sq m**
	Continuous fallow:	**349tons C/ha**	**34,9kg/sq m**

(note: 20-23% C held between 100-200cm depth; 7-8% held between 200-300cm depth)

SE England:	**150years continuous cultivation:**	**27tons C/ha**	**2,7kg/sq m**
	100 yrs woodland regeneration:	**75tons C/ha**	**7,5kg/sq m**

SKO: Kazakhstan :	**1% humus, 0-50cm**	**30tons C/ha**	**3,0kg/sq m**
	2% humus, 0-50cm	**60tons C/ha**	**6,0kg/sq m**

(See also Section 14 of Annex C for details of SKO organic-C stocks.)

Possible Soil-C Sequestration from LandManagement Changes:

Carbon sequestration potential of arable land management strategies for European soils:

Land management practice	**Potential C sequestration rate (tC/ha/yr)**	**Additional C savings (tC/ha/yr)**
Animal manure incorporation (13 t /ha /yr)	0,37	
Sewage sludge application (1 t /ha /yr)	0,26	
Cereal straw incorporation (6 t /ha /yr)	0,69	
Conversion to no-till farming	0,39	0,02[1]
Agricultural extensification (ley-arable rotation)	0,54	
Natural woodland regeneration on arable land	0,62	2,8[2]
Bio-energy crop production on arable land	0,62	6,0[3]

[1]Fossil fuel saving; [2]vegetation C accumulation; [3]vegetation C accumulation: of this, 2,1t/ha/yr represents energy substitution potential.

Source: Falloon, D., Powlson, D. and Smith, P. 2004. Managing field margins for biodiversity and carbon sequestration: a Great Britain case study. Soil Use and Management, Vol. 20, pp 240-247.

Carbon Taxation and Credits

European emissions trading:

Price of permits per tonne of CO2 has varied between :	**Eur8**	**-**	**Eur30 / tonneCO2**
which is equivalent to:	**Eur29**	**-**	**Eur110 / tonne C, or:**
	US$41	**-**	**$157 / tonne C**

Discussions within EU and individual countries on Introduction of Carbon Tax, and possibilities for combined system of Carbon Taxation and Carbon Credits.

Level of taxation would possibly be introduced at around **$100 / tonne C**, and credits would be fixed at same level. Income Tax or VAT would be reduced in each country to compensate for this Carbon Tax. This would mean that big users of C-fuels would pay more tax, small users less tax, and owners of land sequestrating CO2 would get a further credit or subsidy.

Implications of carbon taxation @ $100/tonne:

- Increase in petrol, diesel, aviation fuel & heating oil prices by $0,13 / litre.
- Increase in coal-fired electricity prices by $0,01 - $0,015 / kwh

Implications of credits @ $100/tonne:

- **Monitoring of Land Use and Soil Carbon Status would become extremely important**
- **(in EU monitoring program would form part of routine monitoring for farming & environmental subsidies)**
- **(in W Europe many farmers would get $20-40 /ha/ year and some farmers would get up to $100 /ha /year for better land use practises, and an up-front credit of up to $600 /ha /year for bio-energy crop production – see above examples).**
- **In Kazakhstan, better farming practises would sequester less CO2, but rates of up to ½ of W Europe rates would be expected: best farmers might get $50 / ha/ year for soil-C**
- **GosNPCZem is currently monitoring humus in 0-50cm layer for the SO bonitet reassessment surveys and this could form part of national Soil-C reassessment program;**

Monitoring agricultural practises and carbon sinks in soil and vegetation would be aimed for both taxation and credits: cultivation of marginal steppe lands may well prove to be uneconomic if carbon taxation were to be imposed.

Main Sources of Carbon in the Earth's Surface Materials

	Pg C (=bln tonnes)	tonnes C /hectare	tonnes C /sq metre	kg C /sq metre
Atmospheric CO (as of 1978)	696	13,6	0,0014	1,4
Oceanic CO2, HCO3, CO3	34800	680,8	0,0681	68,1
Limestones & other carbonate sediments	64800000	1267641,6	126,7642	126764,2
Carbonate in metamorphic rocks	2640000	51644,7	5,1645	5164,5
Total biomass	594	11,6	0,0012	1,2
Organic carbon in ocean water	996	19,5	0,0019	1,9
Organic carbon in soils	2064	40,4	0,0040	4,0
Organic carbon in sedimentary rocks	12000000	234748,4	23,4748	23474,8
Organic carbon in metamorphic rocks	3480000	68077,0	6,8077	6807,7

Source: *Encyclopaedia Britannica*, 2007.
(Subsequent calculations by the Consultants)

Rothamstead, Herts, UK: Soil Organic Carbon Contents:		
Arable soils, 150years continuous cultivation:	27	2,7
Former arable, 100years of bush/woodland regeneration:	75	7,5

Source: Russell's *Soil Conditions and Plant Growth*, 11th Edn, 1988

Annex G: Terms of Reference

APPENDIX A
Sheet 1 of 11

BACKGROUND INFORMATION AND TERMS OF REFERENCE (TA No. 4375 - KAZAKHSTAN)

ENVIRONMENTAL MONITORING AND INFORMATION MANAGEMENT SYSTEM FOR SUSTAINABLE LAND USE

Background

1. The Government of Kazakhstan requested advisory technical assistance (TA) from the Asian Development Bank (ADB) to improve environmental monitoring and information management system for sustainable use of agricultural land. The TA[1] is included in the country strategy and program (2003) for Kazakhstan. The Government and ADB agreed to include the TA in the Pilot Study for Delegation of Consultant Recruitment and Supervision under Technical Assistance to Executing Agencies (Pilot Study). An ADB Fact-Finding Mission visited Kazakhstan in May 2004 and held discussions with key officials of relevant government agencies. During the discussions, understanding was reached on the TA's objectives, scope, terms of reference for consultants, cost estimates, implementation arrangements, and pilot study implementation procedures.

Title and Location of the Technical assistance

2. The title of the Technical Assistance (TA) is "Environmental Monitoring and Information Management System for Sustainable Land Use". The Technical Assistance will be based in Astana, under the Ministry of Environmental Protection (MOEP). The TA includes a pilot implementation of the environmental system in the South Kazakhstan Oblast (SKO). This implies that the Consultant will have to travel to SKO for variable intervals of time during the TA.

TA Summary

Rationale

3. Agriculture is a significant sector of non-oil production in Kazakhstan, accounting for almost 18% of its gross domestic product in 2003. Forty-four percent of its population live in rural areas. Among the Central Asian countries, Kazakhstan is the largest and its considerable land resources have remarkable potential for agricultural development[2]. About 66% of its land, however, suffers from degradation and threats of desertification, soil erosion, soil dehumidification, and salinization are increasing. The main causes of land degradation are unsustainable land and water management practices, including overgrazing, poor water management in extensive irrigation systems, and inadequate drainage systems. The main economic consequences include reduced crop production, decreased cattle stock and productivity, decreased export capacity in agriculture products, and stagnant food and light industries. Lack of income diversification, decreased farm and rural household incomes, and increased rural poverty are directly linked to land degradation in many of the agricultural provinces. Land degradation has become a major factor constraining economic development, and reversing this trend is an essential ingredient in enhancing the living standards of the rural population.

[1] The NA first appeared in *ADB Business Opportunities* (Internet edition) on 4 March 2004.
[2] The total area of Kazakhstan territory is 272.5 million hectares (ha), of which 222 million ha is agricultural lands.

4. The Government is aware of the problem and has developed a series of strategies to address it. The Long-term Strategy of Development of Kazakhstan Till 2030 outlines long-term goals to improve rural living standards and environmental safety. The State Program of Rural Development of Kazakhstan 2004-2010 emphasizes the development of rural settlements in areas with potential for sustainable income and employment growth under a market economy to encourage migration of communities from regions that have limited prospects for economic growth or are environmentally hazardous. The Concept of Rational Use and Protection of Land Resources for 1994-1995 and for the Period Till 2010 issued by the Government identifies three stages in improving land management, namely, improvement in land tax policy, implementation of land reform, and maintenance of state land cadastre and land monitoring. The 2002 National Action Plan to Combat Desertification and the Concept of Ecological Security 2004-2015 both emphasize the need for a cross-sector approach to implement programs to combat desertification, and recommend activities to be implemented during 2002 and 2011, including development of a methodology for land use analysis, establishment of a monitoring and information management system, and implementation of pilot projects to control desertification

5. While Kazakhstan has adequate strategies for sustainable use of land resources, the process of translating them into local policies and specific programs and projects has been slower and less effective than expected. Among others, inadequate institutional capacity to implement these strategies is a major challenge. The Ministry of Environmental Protection (MOEP) has realized that the gap between the extent of sustainable land use commitments made by the Government and the institutional capacity to implement them is getting wider. This is mainly because the Government has limited experience in coordinating complex environmental management policy across various government agencies, lacks operational mechanisms and procedures to introduce environmental safeguards into agricultural and land management policies and activities, and has inadequate knowledge and information to meet the changing farming needs for sustainable land use. Capacity building and institutional development at local levels *are* particularly needed to address the multifaceted and cross-sector land management issues. Oblast and rayon officials in charge of agriculture and land planning are typically with science and engineering backgrounds and lack skills and knowledge needed to address a broad range of multi-sectoral land degradation issues. Local environmental agencies also lack skills to deal with agricultural and land management concerns as their current tasks primarily relate to industrial pollution issues.

6. Overlapping functions between various government agencies responsible for different aspects of agricultural policies and land management and unclear mandates often make decision making and implementation of decisions related to sustainable land use difficult in Kazakhstan. It is difficult to obtain and compile relevant monitoring data from various sources. There is no mechanism for comprehensive data analysis. Also, Kazakhstan lack an information management system that various agencies can share as a common basis to support cost-effective, cross-sector policy innovations and measures to address worsening land degradation.

7. Lack of an effective monitoring and information management system is not a new problem. Information related to environmental and land management has deteriorated since independence. The most pressing need, however, is not simply to collect data but to review the relevance of the data currently generated and reform it to meet the changing needs for integrated policy development and program or project preparation. Lack of data compatibility, comparability, reliability, and accessibility that are required to link various sectoral networks into an integrated information management system is another problem. For example, criteria for monitoring the land degradation process applied by various land management agencies are inconsistent and do not comply with the United Nations Convention to Combat Desertification (UNCCD) indicators. Thus, it is difficult to integrate some planned activities within the framework of actions on combating desertification. The Government launched Unified Information Program 2001-2006 to deal with this problem.

8. Environmental auditing as part of the monitoring and information management system for sustainable land use is necessary to facilitate the implementation of national strategies and plans for fighting land degradation. An effective and practical auditing system provides standards for

efficient use of water and other agricultural resources, offers approaches to audit actual conditions, and identifies best practices options to meet the standards and minimize adverse impacts on land. This type of auditing system is almost completely missing in Kazakhstan. Such a system is essential to develop ideas and build knowledge for agricultural agencies and farmers to apply best practices that can reduce production costs while gaining environmental benefits.

9. The important link between improved natural resources management and poverty reduction is recognized both in ADB's country strategy for Kazakhstan and regional strategy for Central Asian countries. Kazakhstan accords high priority in improving land management and participated in one advisory TA and ten regional TAs. Lessons from most relevant TAs[3] include (i) capacity building focusing only on the central Government tends to be too theoretical and not directly related to the specific needs of the institutions, and (ii) sustained capability to better manage the environment is best carried out by involving agencies other than environmental agencies at both national and local levels. The ADB supported Central Asian Countries Initiatives on Land Management (CACILM) emphasizes the mainstreaming of land management considerations into overall sustainable development policies and programs, and covers a range of interactive interventions from policy and legislation development, institutional strengthening to on-the-ground investment projects. Under CACILM, Kazakhstan has developed a National Programming Framework for Sustainable Land Management. This technical assistance project has been included as one of the priority activities in the National Programming Framework. In addition, CACILM will be supporting the development of sustainable land management information systems for Kazakhstan and each of the other Central Asia Countries. Work on the proposed technical assistance must be coordinated with CACILM activities to ensure the resultant information system can be fully integrated into the CACILM sustainable land information management for Kazakhstan.

Goal and Purpose

10. The main goal of the TA is to improve mechanisms for mainstreaming sustainable land management through enhancing institutional capacity in environmental auditing, monitoring, and information management system to support policy development, program preparation, and environmental safeguards for sustainable land uses. Specifically, the TA will:

- Develop methodologies and operational guidelines on improving environmental auditing, monitoring, and information management system.
- Design and implement a trial implementation of the system in response to actual needs of policy development, program preparation, and environmental safeguards for sustainable land use in South Kazakhstan Oblast.
- Prepare a follow-up project aimed at expanding the outcomes of the TA to be financed by the Government in 2008.

Scope of the Consulting Assignment

Outputs

11. The TA will have the following outputs:

(i) Development of methodologies and operational Guidelines to improve environmental auditing, monitoring and information management system for sustainable uses of agricultural land;

(ii) design and implementation of a pilot system in the South Kazakhstan Oblast and, based on the results of this trial

(iii) provision of help to the MOEP to prepare a sector expansion program for inclusion in the 2008 pipeline program to be implemented with Government finance.

[3] ADB. 1999. *Technical Assistance to the Republic of Kazakhstan for Strengthening Environmental Management.* Manila; ADB. 2000. *Technical Assistance for Regional Environmental Action Plan (REAP) in Central Asia.* Manila; ADB. 2000. *Technical Assistance for Combating Desertification in Asia.* Manila

Activities

Development of Methodologies

12. The consultant will, since the early stage of the TA, identify needs ad develop adequate methodologies to audit and monitor environmental indicators related to land use, environmental hazards related to agriculture, soil degradation, use and wastage of water resources. He will propose draft guidelines and operational procedures in environmental monitoring of land use in the month following the preparation of the inception report. The draft guidelines will be the basis for the preparation of the trial pilot system in SKO. In particular the activities of the consultant will include:

- Identification of the national and local needs of environmental auditing, monitoring, and information management systems for the purpose of policy development, program preparation, and environmental safeguards for sustainable land use;
- review of the system design for the information technology and laboratory and analysis components of the Environmental Information Management System developed under TA 6155- REG: Capacity Building in Environmental Information Management Systems in Central Asia
- coordinate development of ail methodologies and operational guidelines with the sustainable land management information systems activities being conducted under CACILM to ensure that the methodologies are fully consistent with CACILM's methodologies and guidelines
- review of the existing monitoring and information programs handled by various agencies, and identification of the gaps in meeting local, national and international needs and standards;
- review of monitoring indicators and methodologies related for data collection, in accordance with UNCCD requirements;
- design and development of cost-effective methodologies and operational guidelines for improving the existing land use auditing and monitoring systems;

13. development of methodologies and operational guidelines will cover (a) clearly defined users; (b) indicators needed for policy development, program preparation, and environmental safeguards; (c) methodology for monitoring and database development and management; (d) mechanism and procedure of information sharing and exchanges among key agencies; (e) data compatibility, comparability, accessibility, and reliability; (f) data analysis methods to meet the major needs of policy development, program preparation, and environmental safeguards; and (g) mechanisms and procedures to facilitate decision making with the information management system.

Trial System in South Kazakhstan Oblast

14. Based on the draft guidelines for the Consultant will design and implement a pilot system for land use environmental auditing, monitoring, and information management in the South Kazakhstan Oblast[44]. Preliminary results to be analyzed in the frame of the interim report are expected to be obtained at the end of month 7 of the TA. In particular the Consultant will:

- identify land use related on-going projects or environmental monitoring programs in the DSKO, eligible to be included in the trial program;
- in coordination with sustainable land management information system activities being undertaken under CACILM, develop a proposal for the scope, location, activities, and implementation arrangements for the trial system in South Kazakhstan Oblast;
- present possible test pilot alternative system for in the frame of a workshop on "draft methodology and guidelines and trial implementation arrangement"; one of the purposes of the workshop will be to select the type, location and program of implementation of the test pilot;

[4] The South Kazakhstan Oblast is selected for trial implementation based on the following criteria: (i) an oblast with high percentage of desertification and land degradation, (ii) high incidence of poverty tied in part to land degradation, (iii) oblast government's willingness to participate, (iv) data availability, and (v) complement of other ADB project efforts

- monitor the test pilot for eight months;
- collect and analyze preliminary information no later than month 7 of TA; the outcomes of this evaluation will be integrated as annex "development/improvement of environmental auditing, monitoring and information management systems" to the interim report;
- recommend to MOEP, the Kazakhstan CACILM National Coordinating Council, and to oblast decision makers policy innovations, investment project concepts, and environmental safeguard mechanisms for sustainable land use based on information assessment in the frame of a workshop on "Outcomes of trial implementation, revised methodologies and guidelines";
- complete the trial test, collect and analyze final outputs to be used as inputs to the follow-up project preparation: and
- report on the results of the trial as input into the CACILM sustainable land management information system activities

Follow-up Project Preparation

15. The consultant will prepare a follow-up project to be financed by the government to expand the outcomes of the TA, in 2008. The scope of the project will not be limited to dissemination of methodologies for environmental monitoring and database establishment; it is expected to put particular emphasis on the impacts of the information management system on downstream policy improvement and institutional changes. Min activities under this task will include:

- establishment and justification of a list of priorities in the land use environmental monitoring subsector nationwide;
- prepare a project investment proposal for a nation wide sustainable land management information system to be implemented under Kazakhstan National Programming Framework as part of the overall CACILM Framework:
- establish and propose an implementation plan;
- carry out cost estimates and propose a financing plan;
- recommend project implementation arrangements taking into consideration the contributions in expertise and personnel which should be drawn from the various government agencies.

Workshops

16. As milestones, four interagency workshops will be held to discuss TA implementation design, solicit comments on TA findings, and reach consensus among key stakeholders. As key members of the steering committee, the Ministry of Agriculture, the Land Resources Management Agency, the Working Group of UNCCD (or its successor, the Kazakhstan CACILM National Coordinating Council), and MOEP will each be responsible for organizing one workshop. Consultants will conduct a series of on-the-job training seminars for national and local government staff during TA implementation. National and local nongoverment organizations (NGOs) will be involved in TA design and implementation. In addition to NGOs' participation in workshops and pilot project implementation, sections on NGOs' roles as monitoring and information network facilitators and in policy development will be defined as part of the overall methodology and guidelines

17. The first workshop will discuss the outlines of the methodologies and guidelines. The organization of the first workshop should be closely coordinated with the Working Group of the UNCCD (or its successor, the Kazakhstan CACILM National Coordinating Council). The workshop should feature a presentation of the Sustainable Land Management Information System to be developed under CACILM. Formal working arrangements should be developed between the project and the team responsible for the implementation of sustainable land management information system activities under CACILM. The second will discuss the drafted methodologies and guidelines and the trial implementation arrangement. The third will assess outcomes of trial implementation, and discuss the revised methodologies and guidelines responding to the results of the trial implementation. The last workshop will discuss the draft proposal of the follow-up program and overall TA findings.

Provision of Equipment

18. The consultant will procure the equipment for office and for the implementation of the pilot system in SKO. Procurement of the required hardware and software shall be in accordance with the ADB guidelines for procurement of goods.

Consulting Services

19. The TA will be implemented during 14 months, from 1 October 2006 to 30 August 2007. The total consultant input is estimated at 52 person-months: 12 international and 40 domestic. An international consulting firm in association with domestic consultants will be engaged in accordance with ADB's Guidelines on the Use of Consultants and other arrangements satisfactory to ADB for the engagement of domestic consultants. ADB will select and engage consultants following the quality- and cost-based selection (QCBS) procedure , using simplified technical proposal (STP) method. The international consultants will have solid experience in (i) land management (5 person-months, team leader); (ii) environmental auditing and monitoring (land-related, 3 person-months); and (iii) environmental information management system (4 person-months). The domestic consultants will have proven expertise in (i) land use planning policy (deputy team leader, 7); (ii) agricultural economics and rural development (4); (iii) geographic information system (5); (iv) information technology (hardware, software, and web design, 3); (v) soil science and environmental monitoring (4); (vi) water resources management (2); (vii) legal and institutional aspect *of* land management (3); and (viii) rural sociology and poverty reduction (3). The unallocated person-months of domestic services will be used to provide inputs identified as the design of the Project becomes more specific during TA implementation.

Terms of References for Consultants

International Consultants

20. The **Land Management Expert (Team Leader),** will have a background in agriculture engineering or soil sciences, or equivalent degree, with solid references in environmental management. Working in close collaboration with the deputy team leader, he will:

- (i) prepare the work program of the domestic team of experts and coordinate day-to-day-activities among the team of consultants;
- (ii) maintain close relationship with the MOEP;
- (iii) maintain liaison with the team responsible for the implementation of sustainable land management information system activities under CACILM
- (iv) maintain liaison between the consultant team, MOREP, TAMU and the South Kazakhstan Oblast Administration;
- (v) Introduce international experience in monitoring and information management system to prevent and control land degradation/desertification and best practices that may be applicable to Kazakhstan;
- (vi) (vi) develop a pilot-based monitoring and information management system in the South Kazakhstan Oblast in response to the oblast's actual needs for policy development, program preparation or environmental safeguards, possibly covering (a) an inventory of its significant characteristics reflecting land use and land quality (landforms, vegetation, water resources status, biodiversity status, soil nutrient status, agriculture systems, and current practices in the use of land resource), (b) database and statistic mapping reflecting other key socioeconomic, legal, institutional, and technical indicators; (c) assessment of varied policies and investment programs related to poverty reduction; desertification control; development plans on agriculture, forestry, water resource and land use, rangeland and livestock management; and (d) environmental monitoring practices;
- (vii) coordinate development of ail methodologies and operational guidelines with the sustainable land management information systems activities being conducted under CACILM to ensure that the methodologies are fully consistent with CACILM's methodologies and guidelines

(viii) recommend to decision makers of the South Kazakhstan Oblast practices on policy improvement, program preparation, and establishment of an environmental safeguard system for sustainable land use, based on an assessment of the effectiveness of land management policies and investment programs;
(ix) revise and finalize the methodologies and guidelines based on the findings of the trial system implementation in South Kazakhstan Oblast;
(x) report on the results of the trial as input into the CACILM sustainable land management information system activities:
(xi) prepare a project investment proposal for a nation wide sustainable land management information system to be implemented under Kazakhstan National Programming Framework as part of the overall CACILM Framework:
(xii) prepare the guidelines on environmental auditing, the reports and organize the workshops.

21. The **Environmental Auditing** and **Monitoring Expert (land related)** will have proven references and background in land and soil related environmental auditing and monitoring in areas with prevailing geographical and climate situations comparable with Kazakhstan. He will work in close collaboration with the team leader and with the national team of consultants, particularly the soil science and environmental monitoring expert, the legal and institutional expert and the rural sociology and poverty reduction expert. In the frame of the TA the Environmental Auditing and monitoring expert will:
(i) together with the domestic consultants, review current procedures in environmental auditing, monitoring and reporting related to land use;
(ii) identify the national and local needs of environmental auditing and monitoring for the purpose of policy development, program preparation, and environmental safeguard for sustainable land use;
(iii) identify best practices options to meet standards and propose procedures for monitoring the land degradation process that comply with international standards and particularly with the UNCCD Indicators;
(iv) propose an effective and practical auditing system as management tool for efficient use of land, water and other agricultural resources taking into consideration the needs for agricultural agencies and farmers to improve agricultural practices by associating optimum cost-benefits yet minimizing adverse impacts on land and water resources; in particular, make sure that the system is conform with the CACLIM;
(v) design the program for the implementation of land environmental auditing and monitoring in the frame of the trial system in South Kazakhstan Oblast;
(vi) provide inputs to the various deliverables as well as to the workshops.

22 The **Environmental Information Management Systems** expert, will have a solid background in IT supported environmental information management systems and preferably also a background in soil sciences or related disciplines (e.g. geology or agronomy). His main partners among the domestic consultants team will be the Information Technologies expert and the Geographic Information Systems expert. During his assignment he will:
(i) review current IT supported Information management systems in use among government agencies;
(ii) review of the system design for the information technology and laboratory and analysis components of the Environmental Information Management System developed under TA 6155- REG: Capacity Building in Environmental Information Management Systems in Central Asia
(iii) assist with the preparation of all methodologies and operational guidelines to ensure that the methodologies are fully consistent with CACILM's methodologies and guidelines for the sustainable land management information systems:
(iv) elaborate specifications for equipment (hardware, software) needed for the implementation of the trial system in SKO and for the preparation and testing of the environmental information management system;
(v) review and assess the main existing monitoring and information programs handled by various agencies, and identify the gaps in meeting the national and local needs with particular concern to the transfer and handling environmental data related to land use;

(vi) assess the needs and propose alternative solutions for the implementation of a new environmental monitoring management in the frame of the first workshop on the outlines of the methodologies and guidelines;
(vii) design and develop, on the basis of the assessed needs, a new Environmental Information Management System, taking also into account requirements for (a) compatibility for inter-agency exchange of information; (b) simple procedures for data acquisition and transfer and (c) data analysis, reporting and dissemination of information;
(viii) in coordination with sustainable land management information system activities being undertaken under CACILM, develop a proposal for the scope, location, activities, and implementation arrangements for the trial system in South Kazakhstan Oblast;
(ix) provide, as needed, inputs to reports and to preparation and delivery of workshops.

Domestic consultants

23. The domestic consultant which will be incorporated in the team of consultants are expected to play a technical role and provide inputs as expected in the TA, rather than being used as translators or interpreters in TA implementation. They will perform the following tasks:

(i) through document reviews, surveys, and interviews with national and local key stakeholders, analyze data and information that will identify the gaps in the existing environmental auditing, monitoring, and information systems as well as national and local needs; organize this information in a form facilitating review and analysis by the international consultants;
(ii) help the international consultants understand the Government's perception of existing opportunities to learn from international experiences;
(iii) help the international consultants carry out the pilot-based monitoring and information management system, that is, collect data for selected indicators, develop the database and mapping; compile a data dictionary, prepare the user's manual, design appropriate map templates, design and develop a web site in consultation with the oblast users;
(iv) help the international consultants design and organize the training program, and provide appropriate services as resource persons;
(v) Together with the international consultants, help the Ministry of Environmental Protection (MOEP), the Executing Agency, draft all the documents specified as TA outputs.
(vi) Provide support to the international consultant and particularly to the team leader, to organize and held four workshops during the implementation of the TA.
(vii) Provide, as needed, inputs to reports and deliverables.

24. The **Land Use Planning** Expert (Deputy Team leader) will be working in close cooperation with the Team Leader of the TA. In particular he will

(i) provide support to the Team Leader in the completion of all tasks under the competence of the Team Leader

(ii) Substitute the Team Leader in day-to-day transactions with the TAMU, the executing agency and the SKO administration during the period of absence of the team leader from the project.

Implementation Arrangements

25. The MOEP will be the Executing Agency for the TA. A steering committee will be established, chaired by a vice minister of MOEP and comprising representatives from the Ministry of Agriculture, the Land Resources Management Agency, and the Working Group of UNCCD. The committee will provide overall guidance in ihe TA's direction. The committee members will meet 2-3 times during TA implementation. A TA management unit (TAMU) will be established in MOEP to carry out the day-to-day operations of the TA. One senior, qualified

official from MOEP will serve as the head of the TAMU and function as the overall TA coordinator. A junior staff will serve as administrative assistant. The TAMU will comprise five additional technical experts, one each from the Working Group of UNCCD, Hydrometeorology Center, and Information and Analysis Center of MOEP, and two from the South Kazakhstan Oblast.

DELIVERABLES

26. The consultants will help MOEP deliver the following documents and services as the main technical assistance (TA) outputs: (i) guidelines (methodologies and operational procedures) on environmental auditing, monitoring and information management system for the purposes of policy development, program preparation, and environmental safeguards for sustainable land use; (ii) development/improvement of environmental auditing, monitoring and information management systems to prevent and control land degradation in the South Kazakhstan Oblast, with necessary documents reflecting the outcomes; and (Hi) a project proposal for expansion of TA outcomes to be implemented in 2008.

27. The consultants will also submit an inception report with a detailed work plan for TA implementation to MOEP and the Asian Development Bank (ADB) within 5 weeks after their services begin. A 15-page interim report that discusses major progress to be made, outstanding issues with recommended solutions, and tasks to be completed between the midterm review and the end of the TA will be submitted to MOEP and ADB 7 months after the submission of the inception report, accompanied by ail available draft documents that are specified in para. 26. The draft final report (summarizing key TA findings and recommendations) with all documents specified in para. 26 will be submitted 12 months after the TA begins. The draft final report will be discussed at a tripartite meeting of MOEP, the consultants, and ADB. The consultants will submit the final report and output documents in English and in Russian languages at the end of the TA.

28. The team leader and deputy team leader will be jointly responsible for drafting and finalizing the inception, interim, and final TA reports. The team leader will communicate with ADB and MOEP in a timely manner to report on TA progress and alert ADB and MOEP to any potential problems

Facilities to be provided by the executing Agency

29. The EA will provide: (i) administrative assistance to the consultants for obtaining visas, customs clearances, and other permits to perform their tasks in relation to the terms of reference; (ii) all documents and information available to agencies within the Government and in particular from pertinent departments of the MOEO, the MOA, the CWR and the Land Resources management Agency that will facilitate the work of the consultants; (iii) adequate office space for all consultants with appropriate furniture; (iv) local communications facilities and direct access to international communication facilities (the cost of international communications will be borne by the consultants); and (v) the required counterpart staff to work with the consultants as members of the TAMU.

Annex H: Selection of GIS Map Coverages

Figure H.1. Basemap: Southern SKO

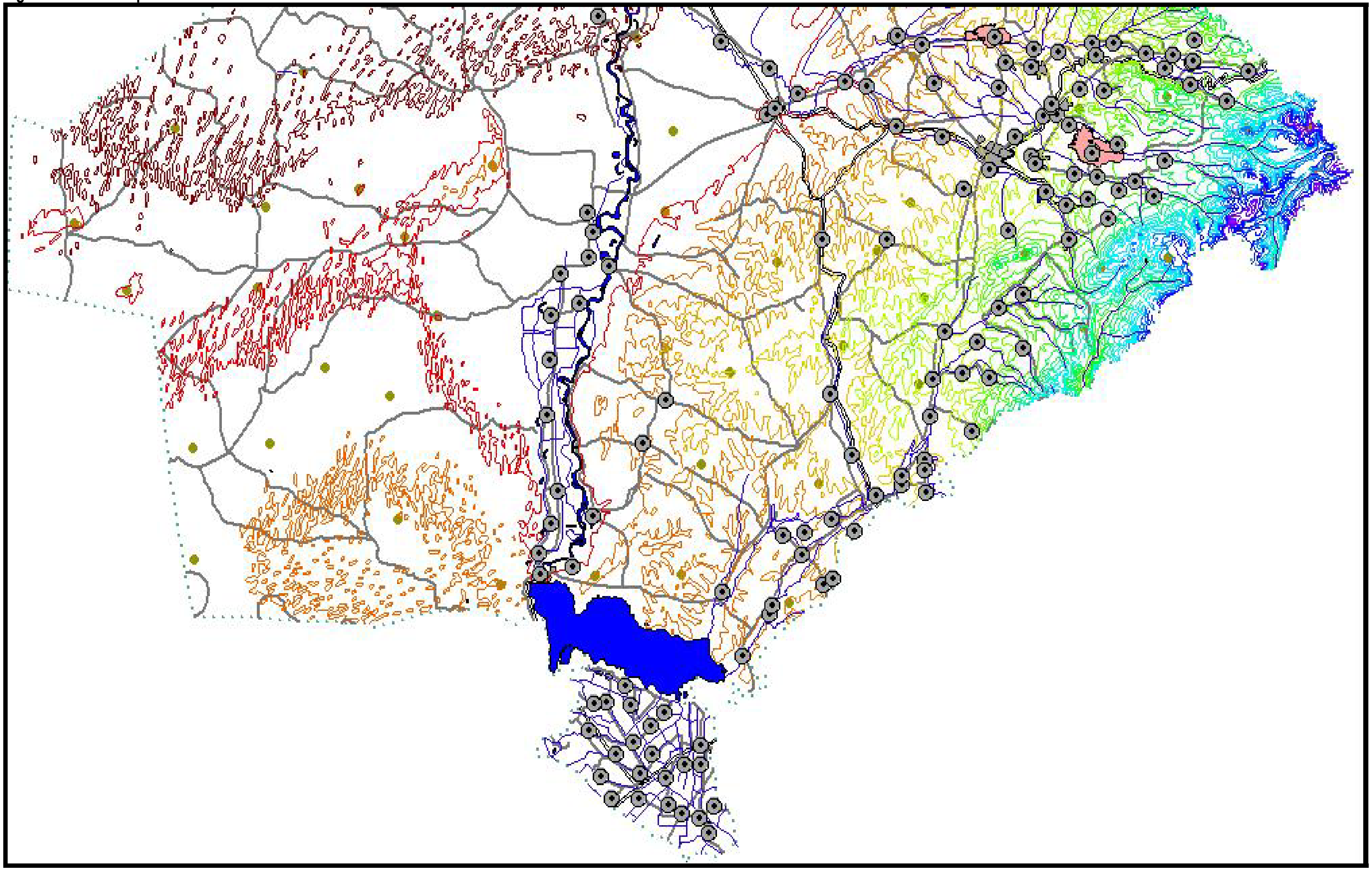

Figure H.2. Basemap: Central SKO

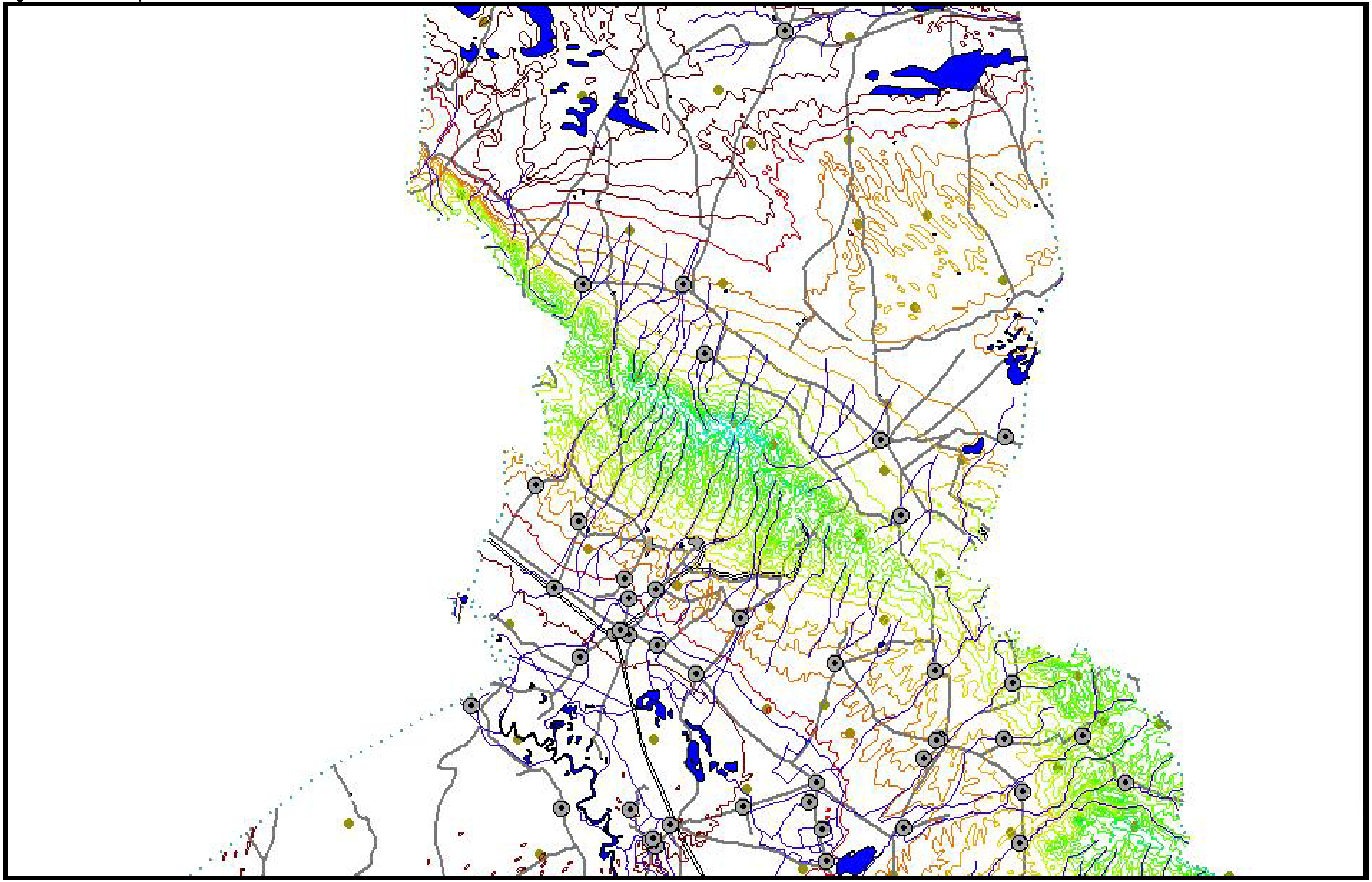

Figure H.3. Basemap: Northern SKO

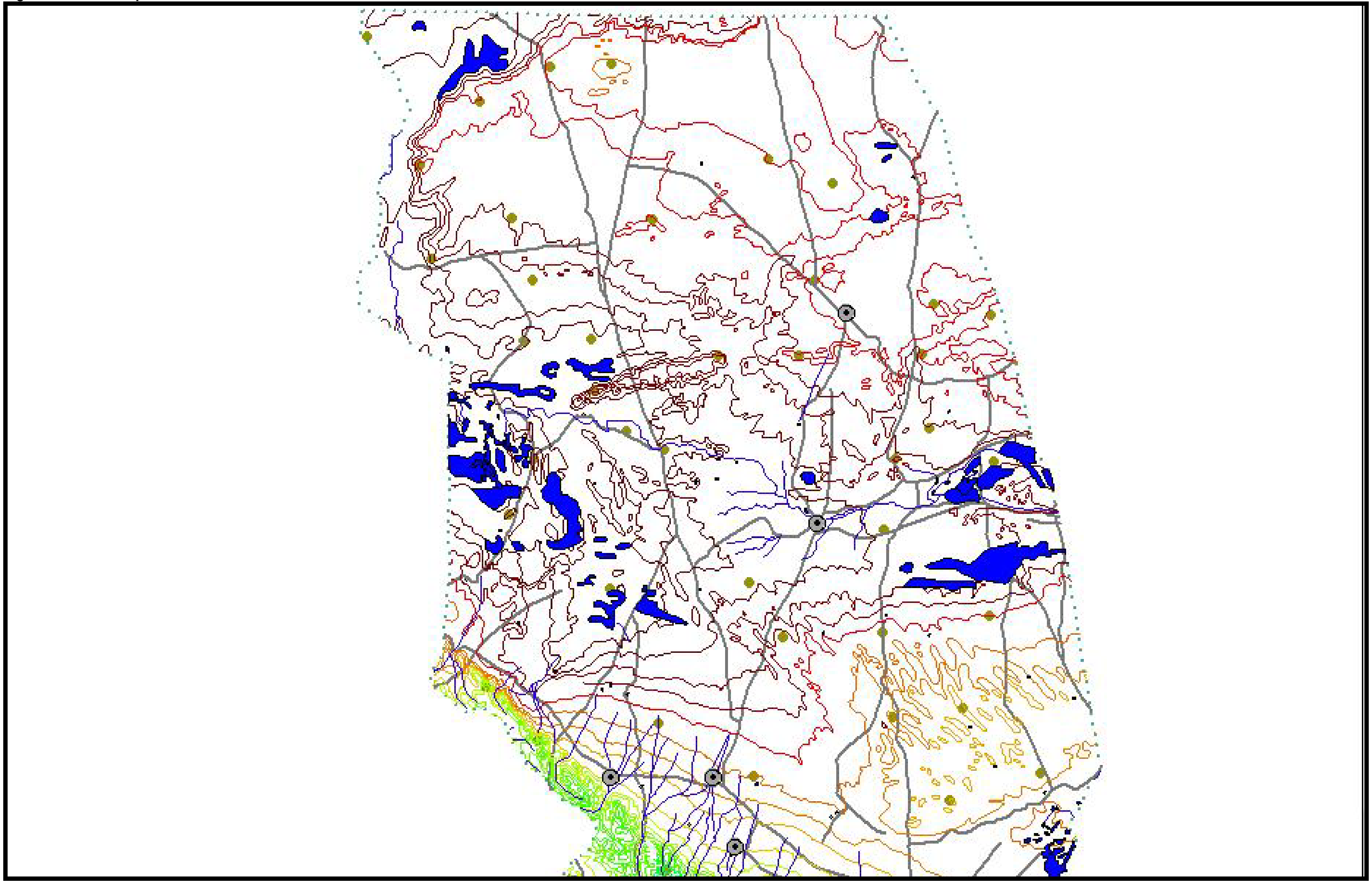

Figure H.4. Project Field Locations in relation to Topography and Mean Annual Precipitation (southern SKO)

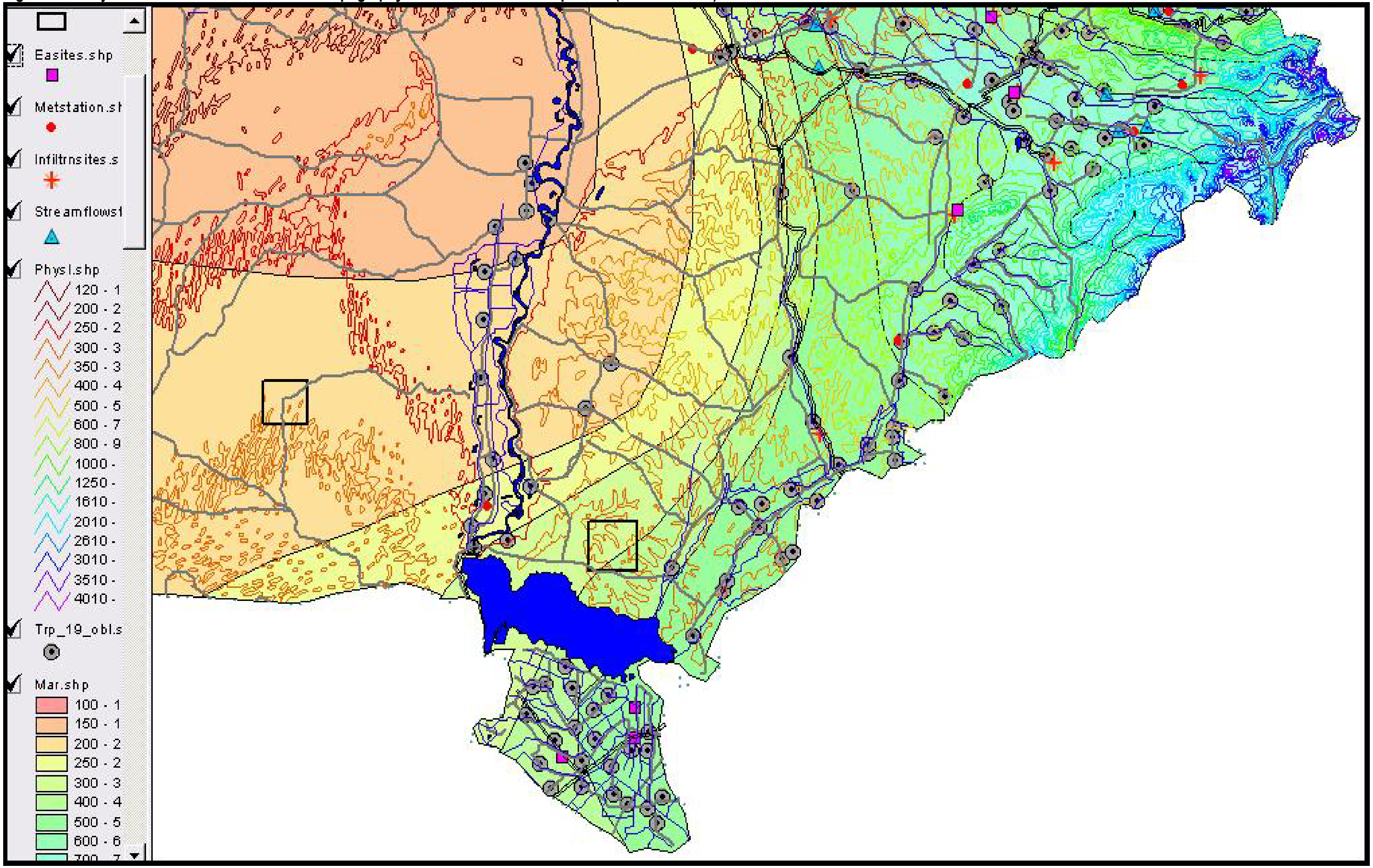

Figure H.5. Project Field Locations in relation to Topography and Mean Annual Precipitation (central SKO)

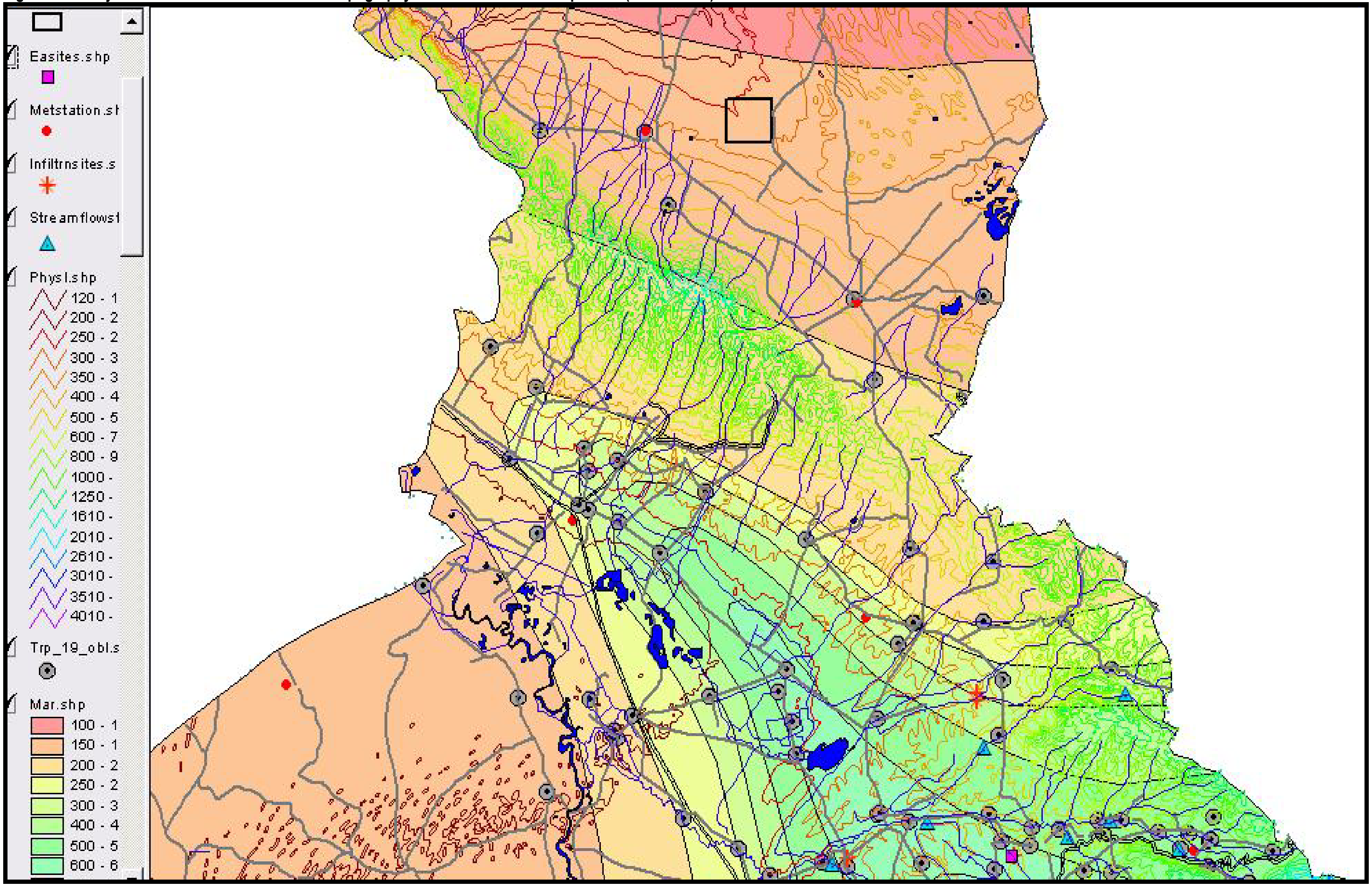

Figure H.6. 2005 Selskiy Okrug Crop / Land Use Areas (Ha) in relation to Mean Annual Precipitation Isohyets (SKO: SE areas)

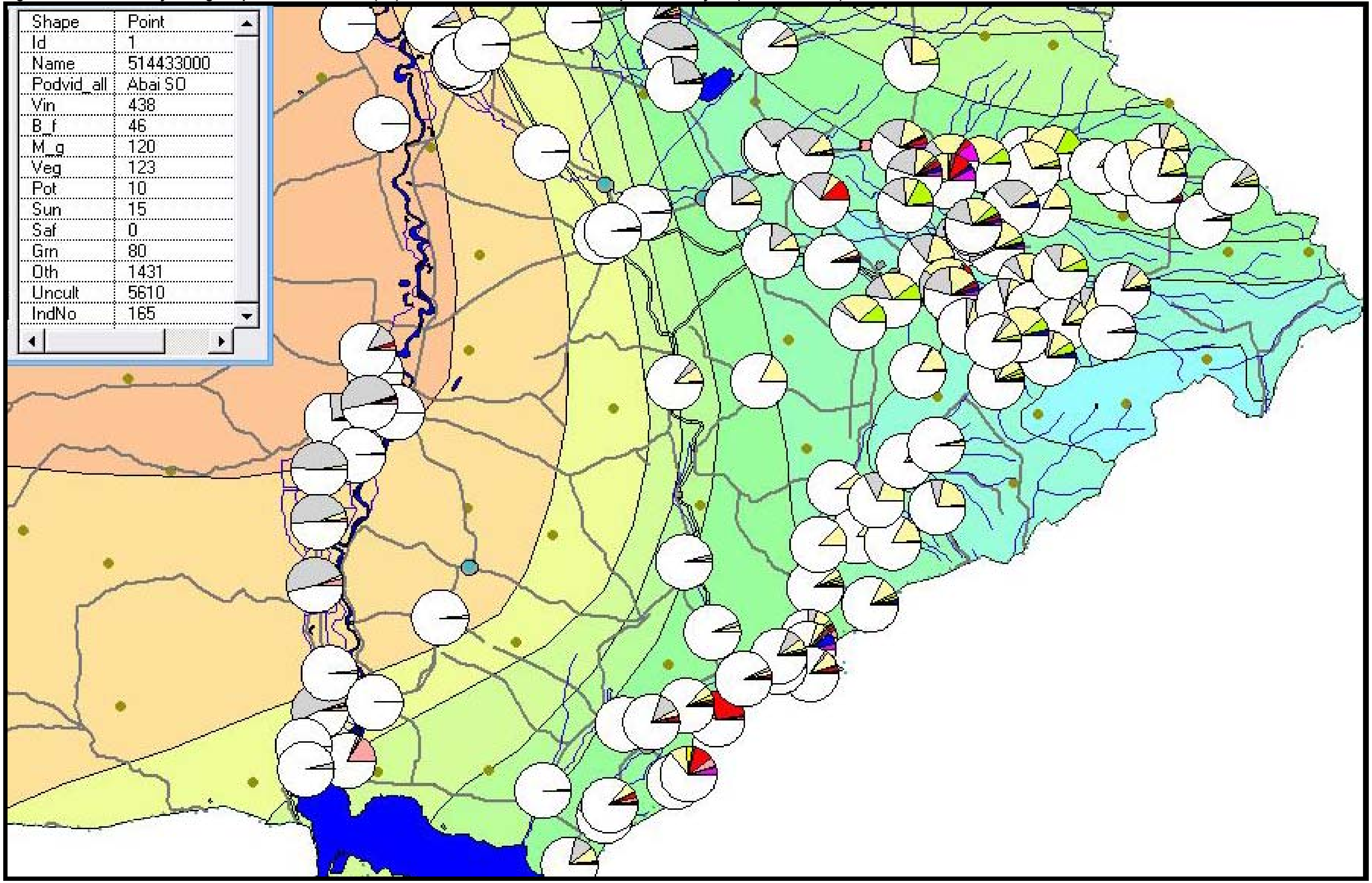

Figure H.7. 2005 Selskiy Okrug Crop / Land Use Areas (Ha) in relation to Mean Annual Precipitation Isohyets (SKO: N areas)

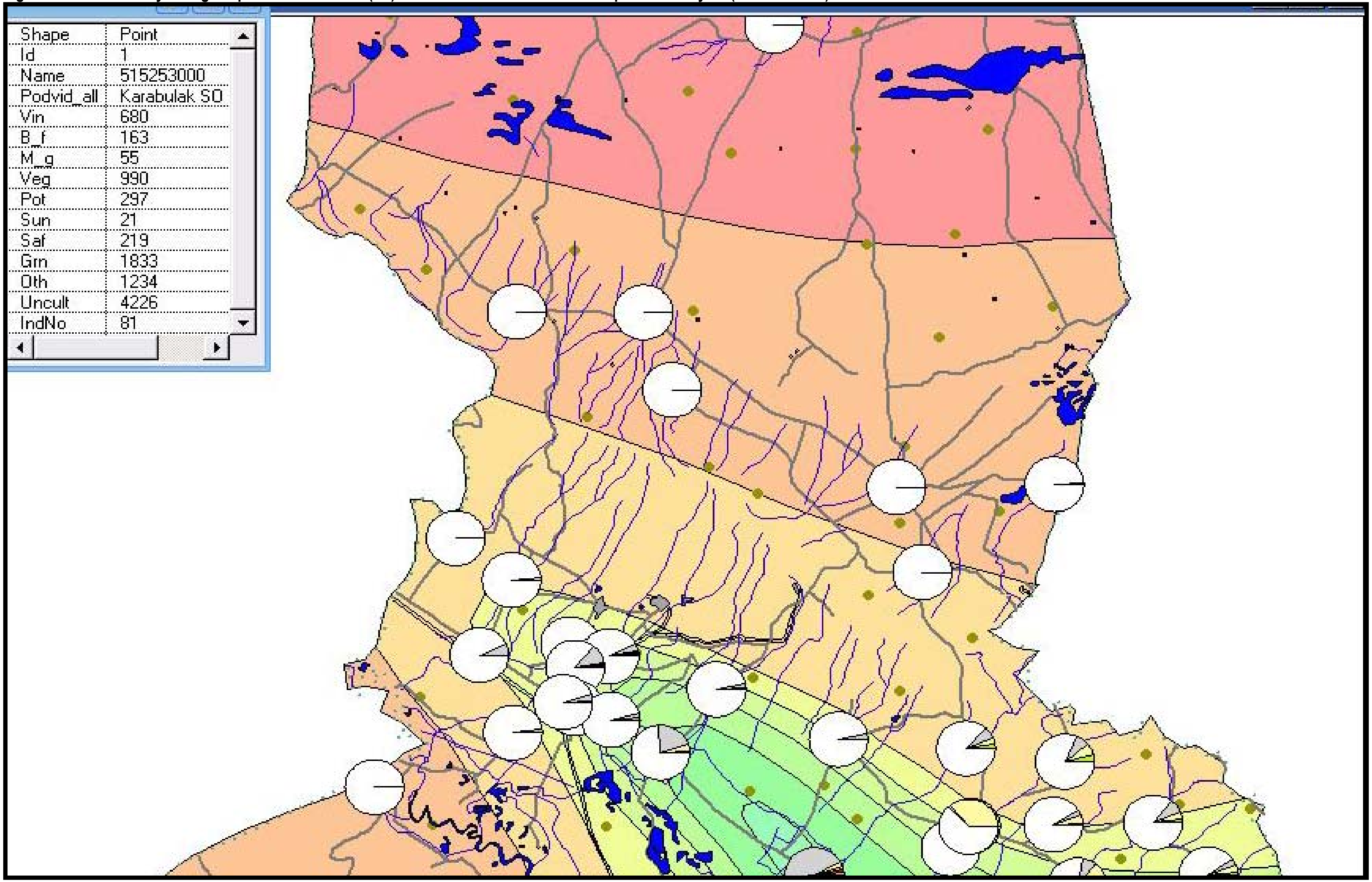

Figure H.8. Land Quality (Bonitet) Assessment Ratings at S.O. level (1970s) for Rainfed (Bonrf-light green) and for Irrigated Lands (Bonirg-dark green + light green)

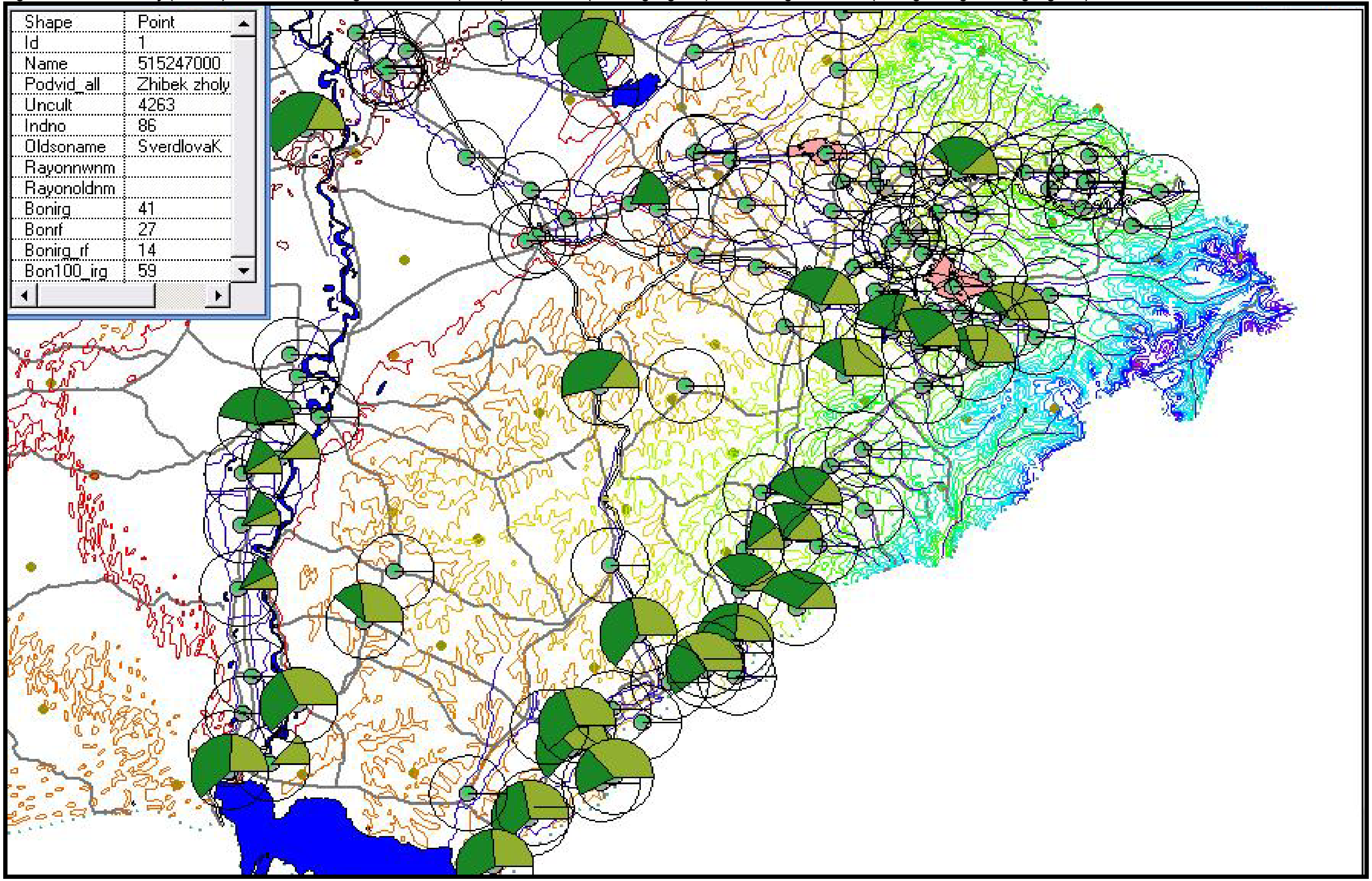

Figure H.9. Changes in Areas of Irrigated Cropping between 1987 (inner pies) and 2004 (outer pies) for the 5 Southern Rayons of the SKO

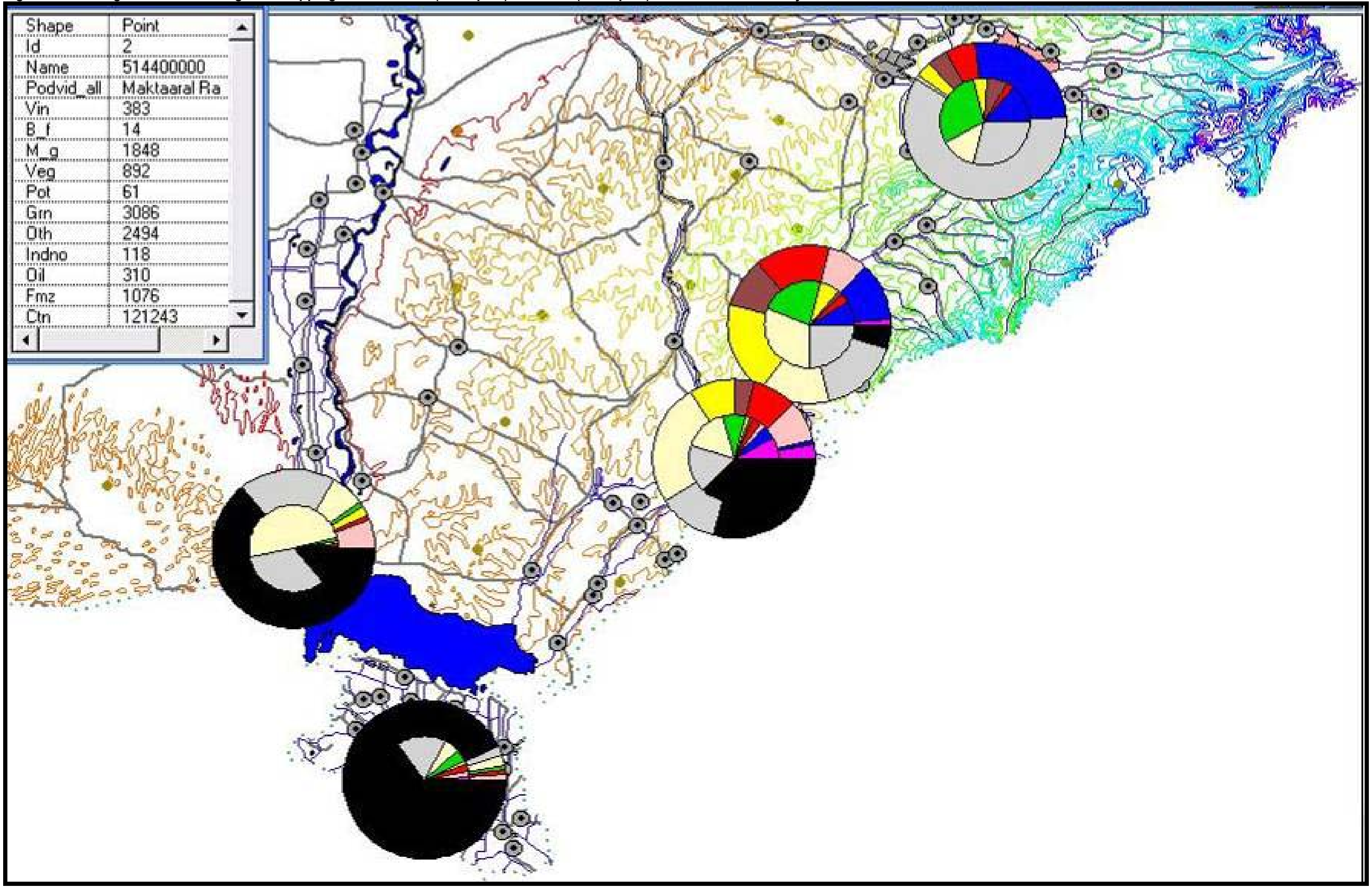

Figure H.10. Changes in Areas of Irrigated Cropping between 1987 (inner pies) and 2004 (outer pies) for the 8 Central and Northern Rayons of the SKO

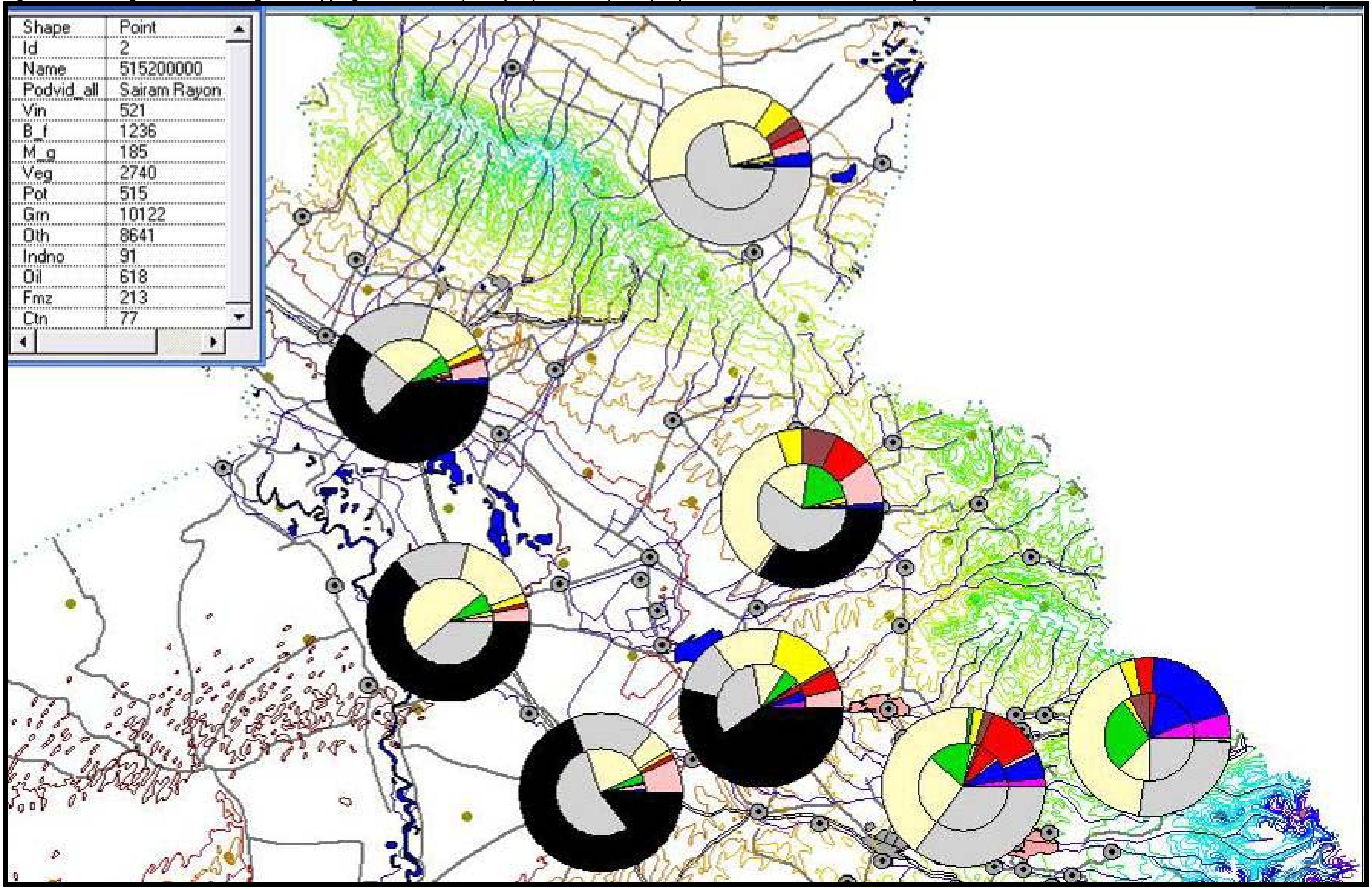

Figure H.11. Erosion gullies and coluvial and alluvial deposition (40km NE of Shymkent)

Figure H.12. Erosion rills and incipient gullies caused by cultivation in slopewise-direction (scale bar 1km)

Figure H.13. Reservoir siltation: approx..15km NW of Shymkent. Scale-bar 1km. Vertical photo.

Figure H.14. Karatau Mountains, approx. 30km ENE of Kentau. Oblique photo.
Shallow soils, poor vegetative cover, steep slopes and susceptibility to flash run-off. Note alluvial fans.

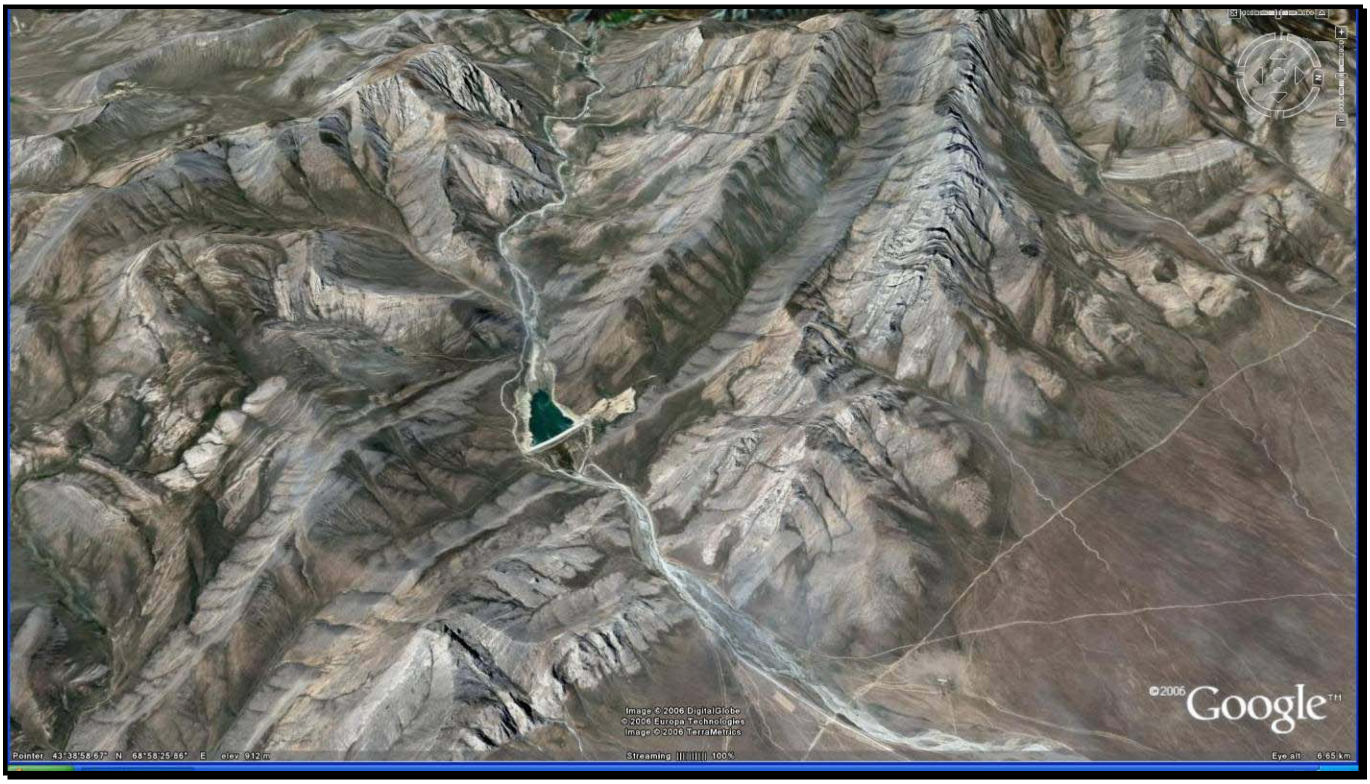

Figure H.15. Aksau –Zhabagli Protected Area: mass-movement slopes and risk of landslides & mudflows

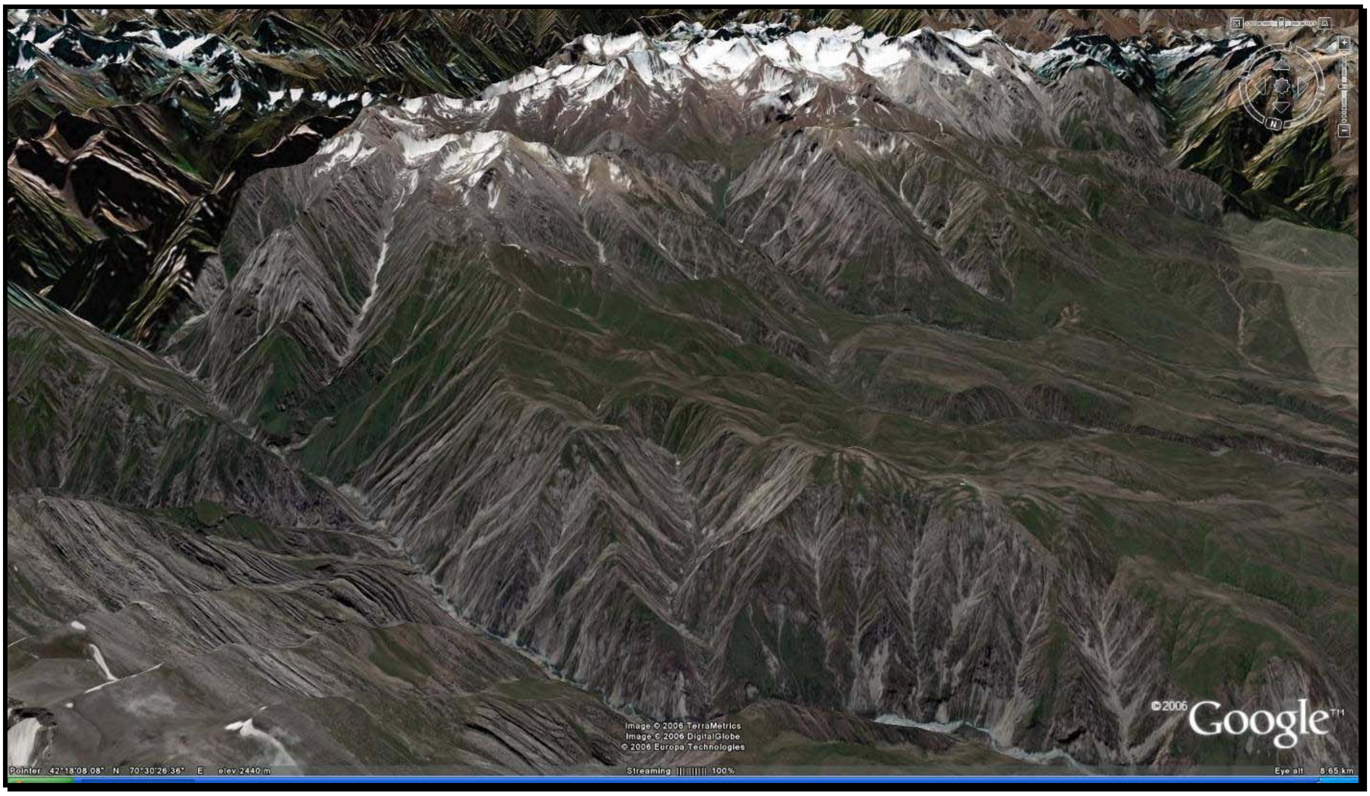

Figure H.16. Zhabagli Village and risk of mudlows and landslides from adjacent mountainous areas. Note massive alluvial fans: remnants of ancient and historic mudflows. Rational land use planning in the adjacent areas to this scenically spectacular area is of the utmost importance.

Figure H.15. Zhabagli village: surface wash erosion on adjacent land; lack of windbreaks; and building & planning issues in the area adjacent to a pristine protected area are major issues here. Scale-bar 100m.

Figure H.16. Kentau. Major areas of derelict and despoiled land due to heavy metal mining and processing. Scalebar 1km.

Figure H.17. Heavy metal processing, W part of Shymkent. Note visible air and river pollution. Scale-bar 1km

Figure H.18. Soil salinity accumulation due to poor drainage design and management, SW of Turkestan.

Figure H.19. Badly eroded area to the South of Lenger. Oblique photo.

Figure H.20. Turkestan, mausoleum. The SKO has been the centre of a thriving agrarian and trading civilisation for many centuries.